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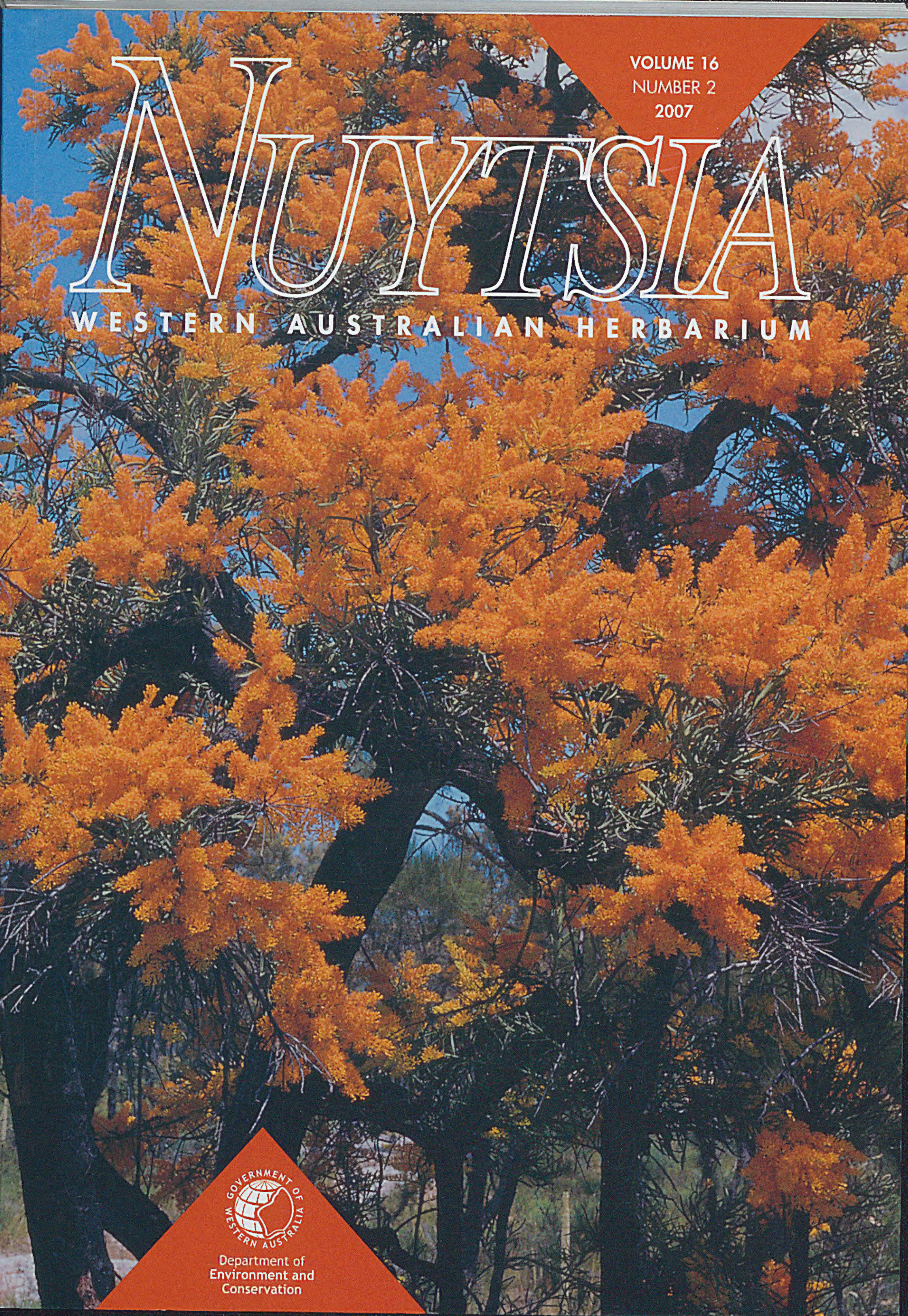

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Cover

Nuytsia floribunda (Labill.) R. Br. ex Fenzl (Loranthaceae) – the Western Australian Christmas Tree is one of the few arborescent mistletoes in the world. This endemic tree is a semi-parasite common in sandy soil from the Murchison River to Israelite Bay. The journal is named after the plant, which in turn commemorates Pieter Nuijts, an ambassador of the Dutch East India Company, who in 1627 accompanied the 'Gulde Zeepard' on one of the first explorations along the south coast of Australia.

Photograph: A.S. George

NUYTSIA

VOLUME 16 NUMBER 2 2007

Western Australian Herbarium
Department of Environment and Conservation
Western Australia

NUYTSIA

Nuytsia publishes original papers on systematic botany with preference given to papers relating to the flora of Western Australia.

Taxonomic revisions and systematic analyses of native plant groups, papers describing new taxa, potential new invasive species, or related topics, and short communications of range extensions and nomenclatural issues are all considered.

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Facsimile: +61 8 9334 0515
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Nuytsia 16(2):265–268 (2007)

A new rare and geographically restricted *Ptilotus* (Amaranthaceae) from the Pilbara Bioregion of Western Australia

Robert W. Davis

Western Australian Herbarium, Department of Environment and Conservation
Locked Bag 104, Bentley Delivery Centre, Western Australia, 6983

Abstract

Davis, R.W. A new rare and geographically restricted *Ptilotus* (Amaranthaceae) from the Pilbara Bioregion of Western Australia. *Nuytsia* 16(2): 265–268 (2007). A distinctive, rare and geographically restricted species, *Ptilotus subspinescens* R.W. Davis (Amaranthaceae), is described from the Pilbara Bioregion of Western Australia. *Ptilotus subspinescens* is only known from several small populations adjacent to the Brockman mine site, 100 km west-south-west of Wittenoom.

Introduction

Ptilotus R.Br. is a predominately Australian endemic genus with one species occurring on the islands to the north of Australia. There are roughly 170 taxa Australia wide. Approximately 90% are found in Western Australia and over a third of these species occur in the Pilbara Bioregion.

A recently discovered species from this bioregion is described here as *Ptilotus subspinescens* R.W. Davis, as part of a continuing study on the genus (Davis 2004). This distinctive new species is almost leafless and has short, tangled, lateral, blue-green branches which are slightly spinescent.

Materials and Methods

This study is based on the examination of herbarium material housed at PERTH.

All measurements were taken from dried specimens except for the staminal cup which was measured from reconstituted material. Hairs were examined using a compound microscope.

Taxonomy

Ptilotus subspinescens R.W. Davis, *sp. nov.*

A *Ptiloto aphyllo* similis sed ramulis lateralibus supspinescentibus, foliis minutis, et cupula staminum elogata appendiculis carentibus differt.

Typus: 59km WNW of Tom Price, Western Australia, 8 Oct. 2004, *E Thoma s.n.* (*holo*: PERTH 07275218; *iso*: CANB, K).

Compact *shrub* to 80 cm high. *Stems* blue–green, terete, glabrous, branching at 40 to 70 degrees and tangled, subspinescent. *Leaves* opposite or alternate, glabrous, shortly petiolate, linear, 2–3.5 mm long, 0.4–0.8 mm wide. *Spikes* terminal, sometimes solitary mostly in loose panicles, hemispherical to ovoid in outline, 5–11 mm long, 7–10 mm wide; 4–12 flowers per spike. *Bracts* broadly ovate, 1.4–1.7 mm long, light brown, margins flared, translucent, glabrous or with sparse septate hairs at base. *Bracteoles* broadly ovate to orbicular, tending to split at the apex, 2.5–2.8 mm long, hairs sparse, septate mostly near midrib. *Outer tepals* pink, elliptical, concave, shorter than the inner tepals, 6–7.2 mm long, apex serrated, attenuate, slightly hooded; outer surface densely villous on margins and lower half, medial section glabrous with septate hairs which are long at the base, becoming shorter and sparser towards apex; inner surface glabrous. *Inner tepals* pink, narrowly elliptic, slightly longer than outer tepals, 6.2–7.5 mm long; apex attenuate, slightly hooded, the margins folded inwards; outer surface densely villous on margins and lower half with septate hairs which are long at the base, becoming shorter and sparser towards apex; inner surface glabrous but appearing hairy due to folded margins. *Staminal cup* elongated, 2.5–2.8 mm long. *Stamens* 5, equal, extending to ¾ of tepals length, filaments brown, broadly dilated towards staminal cup. *Stipe* short, compressed to terete, 0.1–0.3 mm long. *Ovary* ovoid in outline, 1–1.2 mm long, laterally compressed, glabrous. *Style* straight, 4–4.5 mm long, extending beyond tepal apex at maturity, inserted centrally to ovary. *Seed* circular in outline, dull, light brown. (Figure 1)

Specimen examined. WESTERN AUSTRALIA: 50 km SW of Brockman, Aug. 2003, *E. Thoma & A. Joder ET & AJ* 145 (PERTH).

Distribution and habitat. Ptilotus subspinescens is only known from the region around the Brockman mine site, which is situated 100 kilometres west-south-west of Wittenoom in the Pilbara Bioregion of Western Australia. The currently known populations occur in a roughly triangular area *c.* 105 km from north to south by *c.* 50 km wide along its southern side, but only cover an area of about 238 hectares within this larger area. While only two collections have been lodged at PERTH the population status of the species has been investigated by M. Maier (pers. comm.) who has found that there are several populations in the areas of the Brockman mine. There are currently 13 known populations, with the largest of these containing 300–500 plants with an estimated total of 1300 plants from all 13 sites. Only one of the 13 populations is not confined within mining leases. (Figure 2)

The new species has a restricted habitat, preferring gentle rocky slopes, screes and the bases of screes. While such habitat is common in the Pilbara Bioregion, *Ptilotus subspinescens* is only known from a few locations.

Conservation status. Conservation Code for Western Australian Flora: Priority Three. Given the number of populations, low total plant numbers and restricted distribution of *Ptilotus subspinescens*,

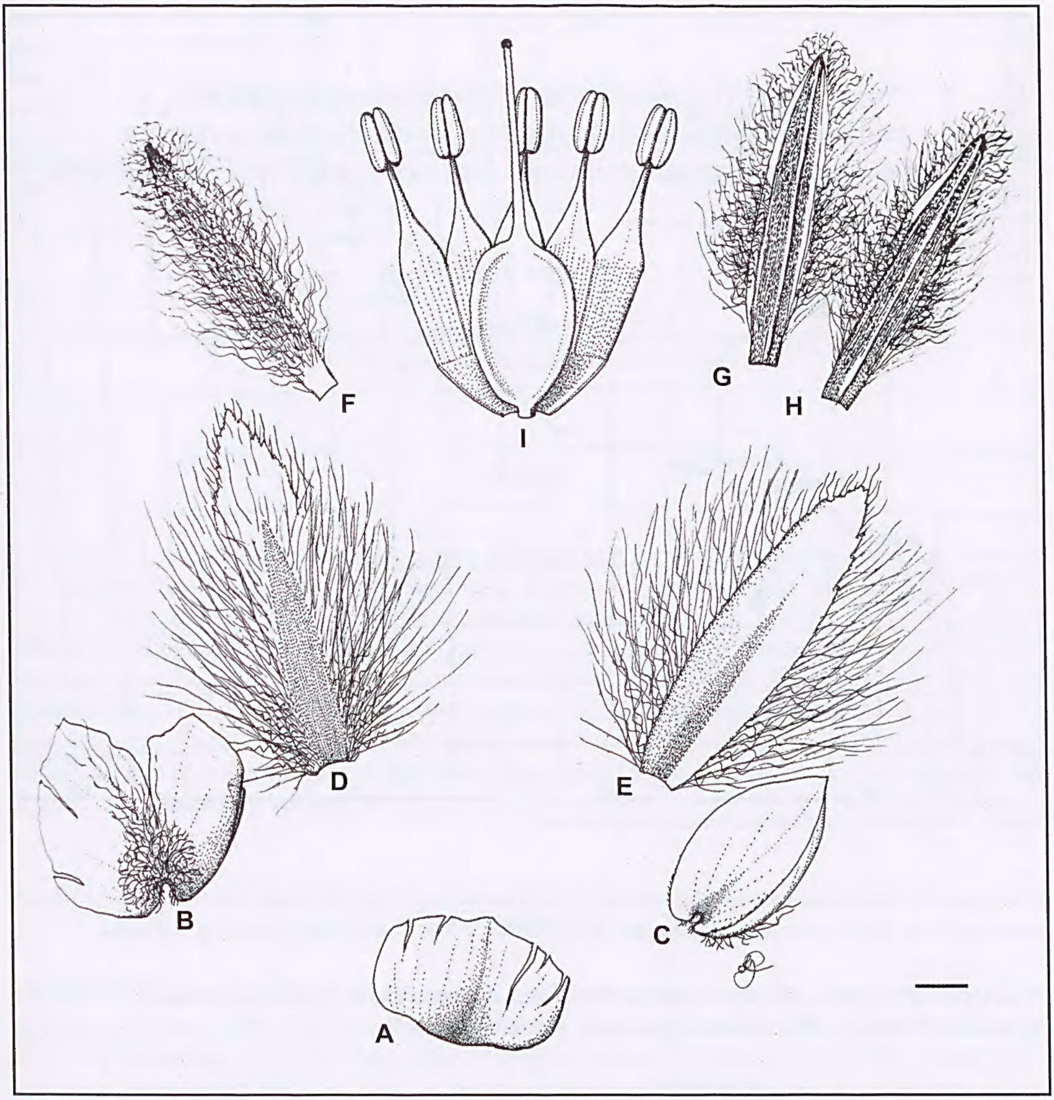

Figure 1. *Ptilotus subspinescens*. A – bract; B - bracteole outer surface; C – bracteole inner surface; D – outer tepal, outer surface; E – outer tepal, inner surface; F – inner tepal, outer surface; G, H – inner tepals, inner surface, showing folded margins; I – foreground ovary, back ground staminal cup and stamens. Line = 1 mm.

a Priority Three rating appears justified. Further surveys are required to fully ascertain the range of *P. subspinescens* and the size of its populations.

Etymology. From the Latin words *sub* (somewhat) and *spina* (a thorn), in reference to the short, slightly pungent lateral branches.

Notes. *Ptilotus aphyllus* is the species that is most similar in gross form to *P. subspinescens*, with both being small almost leafless shrubs. *Ptilotus subspinescens* differs from *P. aphyllus* in its compact rather than open branching habit, rounded rather than angled stems, smaller bracts and bracteoles, entire tepal

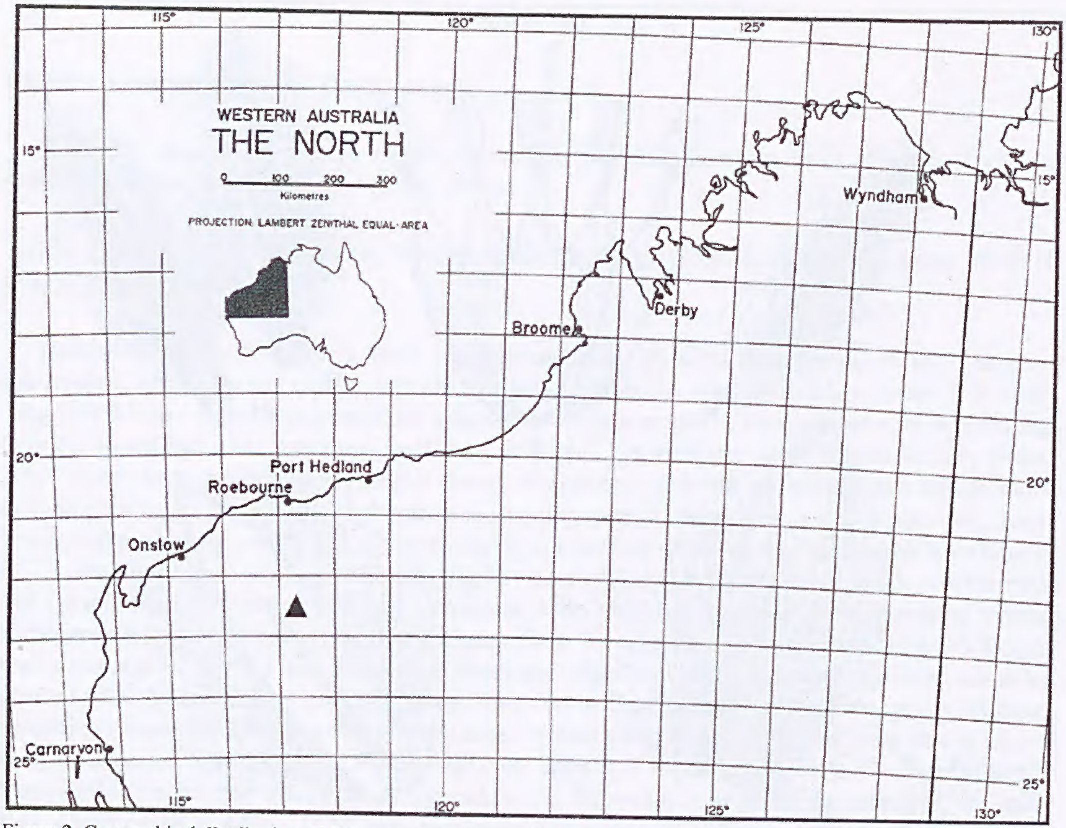

Figure 2. Geographical distribution of *Ptilotus subspinescens* (▲).

apices, and in the absence pseudostaminodes. The two species also differ in habitat preference. *Ptilotus subspinescens* grows on rocky slopes and scree slopes, while *P. aphyllus* grows on red sand.

Ptilotus subspinescens was previously known by the phrase name *Ptilotus* sp. Brockman (E. Thoma & A. Joder ET & AJ 145) (Western Australian Herbarium 2007).

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Special thanks to Malcolm Trudgen for taxonomic advice and Paul Wilson for the Latin description, Lorraine Cobb for her botanical drawings and Mike Hislop for his botanical advice. ABRS made available the unpublished draft key for the Flora of Australia (Benl, unpubl.). Emil Thoma, Michala Maier for providing field survey information.

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Ficus carpentariensis – a new sandpaper fig for northern Australia and a revision of the *F. opposita* complex (Moraceae: *Ficus* subg. *Ficus* sect. *Sycidium* informal group *F. copiosa*)

Dale J. Dixon

Northern Territory Herbarium, Department of Natural Resources, Environment and the Arts,
P.O. Box 496 Palmerston, Northern Territory, 0831 Australia

Abstract

Dixon D.J. *Ficus carpentariensis* – a new sandpaper fig for northern Australia and a revision of the *F. opposita* complex (Moraceae: *Ficus* subg. *Ficus* sect. *Sycidium* informal group *F. copiosa*). *Nuytsia* 16(2): 269–284 (2007). The *Ficus opposita* Miq. complex is revised. Four taxa in three species are recognized, *F. opposita* from Queensland and Papua New Guinea, *Ficus aculeata* Miq. with two varieties, one, var. *aculeata* occurring across the tropical north of Australia, the other, var. *indecora* (Miq.) D.J. Dixon restricted to the Northern Territory and Western Australia. A new species *Ficus carpentariensis* D.J. Dixon which is endemic to the Northern Territory is described. A key to identification is provided along with distribution and habitat and typification notes. Type material has been lectotypified where necessary.

Introduction

There has been a growing body of research provided by Ramirez (1977), Berg (1989; 2003a–e; 2004a–c), Weiblen (2000) and Berg and Corner (2005) that support subgeneric changes for *Ficus* L. With the publication of the Flora Malesiana treatment of *Ficus* (Berg and Corner 2005) including the precursor papers (Berg 2003a–e; 2004a–c) formal recognition has been given to six subgenera within *Ficus*. These include the monoecious subgenera *Pharmacosycea* (Miq.) Miq. and *Urostigma* (Gasp.) Miq., the (gyno)dioecious subgenera *Ficus, Synoecia* (Miq.) Miq., and *Sycidium* (Miq.) Mildbr. & Burret and the subgenus *Sycomorus* (Gasp.) Miq., which contains both monoecious and dioecious species. This new arrangement of *Ficus* differs from that summarized by Corner (1965) by the elevation of section *Sycidium* of *Ficus* subg. *Ficus* to the rank of subgenus and the resurrection of subgenus *Synoecia* (Miq.) Miq. Corner (1960) discussed the recognition of a fifth subgenus that incorporated the sections *Kalosyce* and *Rhizocladus*, but retained them as sections within subgenus *Ficus* because of the close agreement of the floral characters with *Ficus* subg. *Ficus* and supposed absence of a unifying character. Berg (2003a) indicated that the subgenus *Synoecia,* incorporating some of the taxa suggested by Corner (1960) is unified by the two bracteoles that subtend the staminate flower. Berg and Corner (2005) in their adoption of six subgenera have moved the emphasis on identification from floral characters to vegetative characters. These changes have affected the placement of some of the Australian sandpaper figs, albeit without discussion.

In the treatments of Corner (1960, 1965), *Ficus opposita* and the other Australian sandpaper figs were placed in *Ficus* subg. *Ficus* sect. *Sycidium* subsect. *Sycidium* ser. *Scabrae* Miq. In the newly proposed classification of Berg and Corner (2005) and Berg (2003e), the section *Sycidium* is elevated to the rank of subgenus. Berg (2003e) further divided the subgenus into two sections, but below this rank indicated that there were 'several groups of evidently or presumably related species…none with clear demarcations'. Instead Berg (2003e) chose to recognise five informal groups which are primarily based on combinations of Corners (1960) subdivisions. Berg (2003e) placed *F. opposita* in the section *Sycidium*, *Ficus copiosa* informal group which comprises largely the series *Copiosae* Corner.

Ficus opposita and its associated infraspecific taxa have had a varied nomenclatural history. From 1848 when the species was first published by Miquel (1848) to the present, there have been various names published and iterations of infraspecific combinations. The treatment currently followed in Australia is essentially that originally published and summarized by Corner (1965) and followed by Chew (1989) with a slight modification by Henderson (1993). In 1965 and 1989 three infraspecific taxa were recognized, *Ficus opposita* Miq. var. *opposita, Ficus opposita* var, *indecora* (Cunn. ex Miq.) Corner, and *Ficus opposita* var. *aculeata* (Miq.) R.J.F. Hend. (var. *micracantha sensu* Chew 1989).

According to Chew (1989) *F. opposita sensu lato* is a widespread taxon, occurring across the tropical north of Australia and extending into eastern Malesia and New Guinea. Slight geographic cohesiveness was recognised for the infraspecific taxa, but identification was difficult with Chew stating that 'the species is highly variable and the three varieties recognised intergrade considerably and are difficult to distinguish'. Chew (1989) considered that the var. *opposita* was possibly also in the Northern Territory (NT), and New South Wales (NSW), as well as its known distribution of Queensland (Qld), eastern Malesia and New Guinea, var. *indecora* was essentially a western taxon centred in the northern NT and WA, and var. *micrantha* (*aculeata*) extended from Cape York in Qld across the tropical north to Western Australia (WA). Varietal identification was based on leaf and syconia dimensions and the density of pubescence associated with the adaxial and abaxial surface of the leaf. Complicating matters further was the recognition by Hyland *et al.*, (1999, 2003) of the closely related taxon *Ficus cumingii* var. *androbrota* (Summerh.) Corner on Cape York Peninsula. This identification was based on the existence of narrow leafed material in Qld which was very similar to *F. cumingii* var. *androbrota* from New Guinea (*sensu* Corner, 1965).

In the Berg and Corner (2005) Flora Malesiana treatment of *Ficus, F. opposita* is treated without infraspecific taxa. No discussion was provided for the reduction in the number of infraspecific taxa other than a statement in the introduction 'The task [of updating Corner's original unpublished manuscript] proved to be far more extensive and demanding than including recent collections and new data from recent publications…Taxonomic decisions had to be revised (species united or reinstated and the number of varieties strongly reduced)…'. Mention was made of the similarities between *F. opposita* and *F. cumingii* Miq., and the fact that they could be treated as subspecies. The similarities of *F. opposita* with the partly sympatric *Ficus wassa* Roxb., were also discussed. However, Berg and Corner (2005) provided a suite of characters that, coupled with the disjunct distributions of each taxon, allowed for identification and maintenance of these taxa at the rank of species. As part of this treatment though, *F. cumingii* var. *androbrota* was synonymised under *F. opposita* along with the Australian infraspecific taxa. As the *F. opposita* complex has always been problematical, and because some material originating from the NT, could not be reliably placed with any Australian and Malesian material, a revision of the complex was undertaken.

Methods

Material was obtained on loan from the following herbaria: BM, BRI, CANB, DNA, K, L, LAE, MEL, NSW, NT, PERTH, PR, QRS, and U. Herbarium abbreviations follow Holmgren *et al.* (1990). In total 832 herbarium accessions, including spirit material, were examined. With the exception of *Ficus carpentariensis* D.J. Dixon all taxa have been examined in the field and across their respective distributional ranges. Material of *F. carpentariensis* has recently been collected during vegetation surveys in the Macarthur River Region of the NT. All type material has been seen unless stated to be *n.v.*

Taxonomy

Within this complex four taxa in three species are now recognized. These include *Ficus opposita* Miq., which is restricted to the east coast of Australia and New Guinea, *Ficus aculeata* Miq. with two varieties, var. *aculeata* and var. *indecora* (Miq.) D.J. Dixon, and the newly described *Ficus carpentariensis* D.J. Dixon which is endemic to the NT. The other Australian taxon in the informal *F. copiosa* group of Berg and Corner (2005) is *Ficus copiosa* which occurs in rainforests of Queensland's wet tropics and also extending into Malesia. The Australian taxa previously assigned to the series *Scabrae* were not placed by Berg and Corner (2005) in the new informal groups.

Key to species

1. Abaxial surface of leaves with sunken aerolae, leaf margins often distinctly aculeate........ **F. aculeata**
1. Abaxial surface of leaves with areolae not sunken, reticulations slightly raised........ **2**
    2. Leaves ovate, slightly obovate, oblique, elliptic or lanceolate (trilobed) on coppice growth; syconia aculeate, scabrid, pilose........ **F. opposita**
    2. Leaves narrowly elliptic, elliptic; syconia puberulous–pilose, occasionally villous never aculeate........ **F. carpentariensis**

Ficus aculeata Miq. *Lond. J. Bot.* 7: 426 (1848); *Ficus opposita* var. *aculeata* (Miq.) R.J.F. Hend., *Austrobaileya* 4: 119 (1993). *Type:* In Ora Boreali, (Novae Holl.?), Hb. Hook., (*lecto:* K, here designated; *isolecto:* K, U).

Ficus micracantha Miq., *Ann. Mus. Bot. Lugduno-Batavum* 3: 221 (1867); *Ficus aculeata* var. *micracantha* (Miq.) Benth., *Fl. Austral.* 6: 175 (1873); *Ficus opposita* var. *micracantha* (Miq.) Corner, *Gard. Bull. Singapore* 17: 471 (1960). *Type*: Cairncross Is., Qld, *F. Mueller* (*holo:* MEL; *iso:* U, L).

Tree to 15 m, dioecious. *Twigs* solid, with ascending scabrid, puberulous-pilose, villous hyaline hairs, occasionally pilose-aculeate, glabrescent. *Leaves* opposite or alternate, sometimes both conditions occurring on same individual, widely ovate, ovate, occasionally obovate, widely to narrowly elliptic, widely elliptic, margin recurved, rarely flat, aculeate; apex acute, rounded, obtuse–retuse; base oblique, rounded, obtuse, cordate. *Petiole* 2.5–38.0 mm long, scabrid or with ascending puberulous, pilose-villous hyaline hairs, occasionally pilose-aculeate, shallowly channeled on the upper surface, flat gland present at junction of petiole and lamina. *Lamina* 17–182 mm long, 13–96 mm wide, adaxial surface smooth, scabrid, scabrid–aculeate; abaxial surface scabrid or occasionally aculeate along mid and lateral veins, grey pilose-villous, areolae sunken pit obscured by grey pilose-villous hairs or visible with puberulous-pilose hairs; cystoliths visible as raised dots on adaxial surface, crustaceous. *Lateral* veins 4–13 pairs, 44°–90°, basal veins 29°–75°. *Stipules* 4–15 mm long, with puberulous-pilose appressed hyaline hairs, caducous. *Syconia* axillary, ramiflorous, depressed globular, globular, 6.8–16.5 mm long, 6–18 mm in diameter, scabrid, pilose-villous, aculeate, dark maroon red at maturity. *Basal* bracts 3, with puberulouse, pilose hyaline hairs, ciliate, persistent, occasionally evenly spaced along peduncle, or one becoming lateral on the wall of the syconium. *Peduncle* 2–10 mm long, occasionally sessile. *Male* florets ostiolar in 1 row, pedicellate with 4 or 5 tepals. *Stamens* one. *Female* and gall florets sessile and pedicellate, with 3–5 tepals. *Interfloral* bracts absent. (Figure 1)

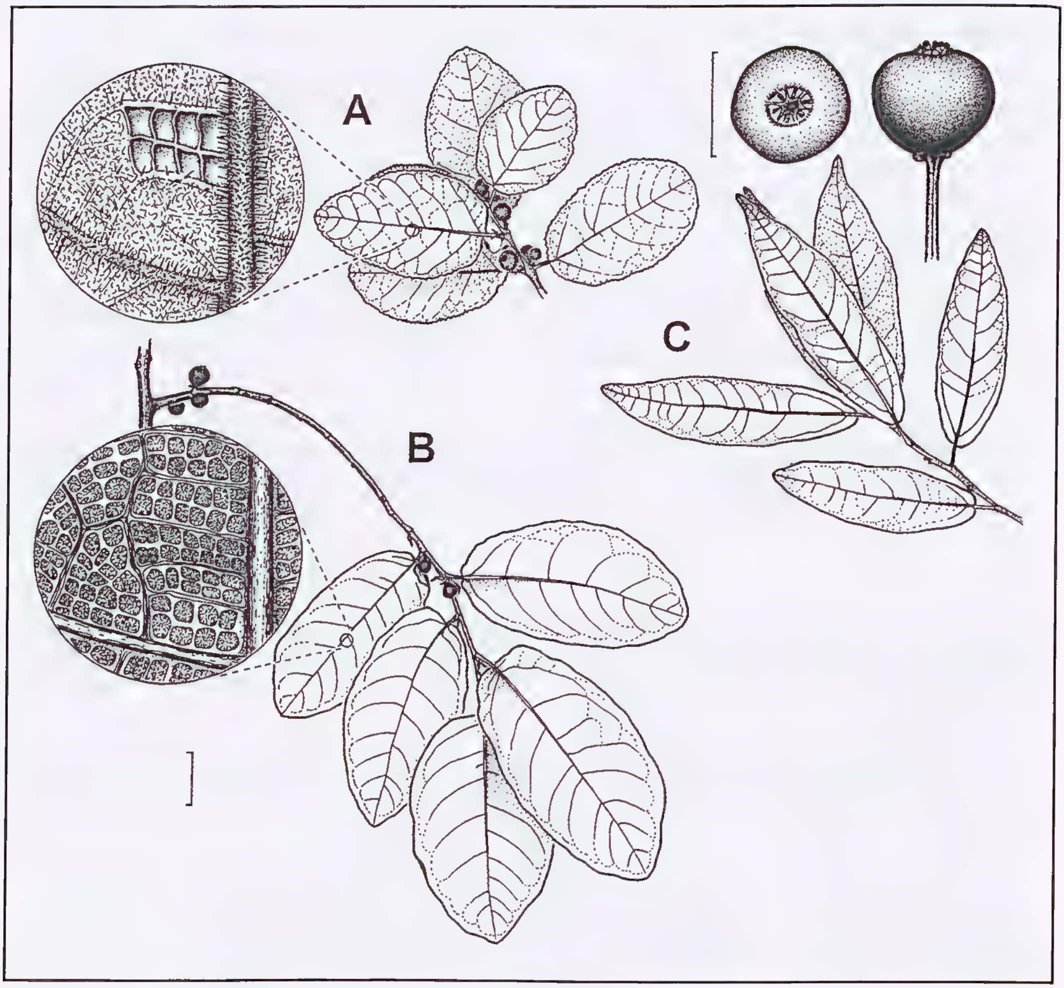

Figure 1. A–C. Leafy twigs and syconia of *Ficus aculeata* and *Ficus carpentariensis*. A – *F. aculeata* var. *aculeata*: fertile branch and undersurface of leaf with indumentum removed to reveal venation and sunken areolae. B – *F. aculeata* var. *indecora*: fertile branch and underside of leaf showing the hair fringed sunken areolae. C – *Ficus carpentariensis*: leafy twig and syconium. Scale bar = 2 cm for A and B and leafy twig of *F. carpentariensis;* and = 1 cm for syconium of *F. carpentariensis*.

Typification. A sheet of *Ficus aculeata* Miq., bearing a label in Miquel's hand exists at K even though Chew (1989, p.57) indicated that type material for this taxon was not designated. This specimen also has a label in Cunningham's hand indicating the north coast (N.C.) collection locality cited by Miquel (1848). This sheet has been chosen as the lectotype. Another sheet, also present at K, bears Cunningham's label with the same collection locality. This duplicate K specimen together with a U specimen consisting of a single leaf and syconia fragments are isolectotypes. It appears that Miquel had a habit of retaining one or two leaves from his 'type specimens' at his home institution (see also *F. micracantha* Miq.).

Chew (1989) indicated that the type of *Ficus micracantha* Miq. was at K. However, after consultation with the ABLO, Dr Roberta Cowan, no material of *F. micracantha* was located at K. *Ficus micracantha* material bearing a label in Miquel's hand has been located at U, while duplicate material has been found at MEL and L. I have no doubt that the MEL, L and U material is from one gathering and since the MEL specimen is the most complete and bears syconia, it is chosen as the holotype.

Notes. In deciding on the nomenclature for *Ficus aculeata*, I have been mindful of the synonymy already established at the specific rank for *F. orbicularis, F. indecora,* and *F. aculeata*. As these taxa were published in the same publication and on the same page (Miquel, 1848), and in my opinion are conspecific, each could be considered as having equal priority for specific recognition. However, Bentham (1873) treated *F. indecora* as a synonym of *F. orbicularis*, which by priority (see Art. 11.5 of the ICBN, Greuter *et al.* 2000) prevents the use of the name *F. indecora* if *F. orbicularis* is considered conspecific, which it is. This leaves *Ficus aculeata* and *F. orbicularis* as the competing names for the above taxon. Bentham (1873) stated that *F. aculeata* was very closely allied to *F. orbicularis* and pondered the notion that it was just a variety. Corner (1959) reduced *F. indecora* to a variety of *F. opposita* and placed *F. aculeata* in synonomy under his newly combined *F. opposita* var. *micracantha* (Miq.) Corner. In this same paper, Corner (*op. cit.*), *F. orbicularis* was also placed in synonymy under *F. opposita* var. *micracantha*. The nomenclature of *F. opposita* remained stable until Henderson (1993) quite rightly pointed out that the treatment provided by Chew (1989) neglected to take into consideration the change to the rules relating to autonyms which was established at the 1981 International Botanical Congress. In correcting the nomenclature of Chew (1989.), Henderson (1993) amended the taxonomy to reflect the status of autonyms, thus *F. opposita* var. *micracantha* became *F. opposita* var. *aculeata*.

Ficus aculeata Miq. is distinct from *Ficus opposita* Miq. which in Australia is essentially an east coast taxon. In order to retain some familiarity of names I have decided to use *F. aculeata* over *F. orbicularis* at the rank of species as the epithet *aculeata* is currently in use (see Henderson, 1993), and would at least be recognisable to those familiar with *Ficus* names in use. There are two varieties that can be distinguished as follows:

Key to varieties of *F. aculeata*

1. Abaxial surface of leaf densely covered with grey pilose-villous hairs obscuring aerolae.. var. **aculeata**
1. Abaxial surface of leaf with aerolae visible, hairs not obscuring aerolae................var. **indecora**

Ficus aculeata Miq. var. **aculeata**

Twigs with ascending puberulous-pilose, villous hyaline hairs, occasionally pilose-aculeate, glabrescent. *Leaves* widely ovate, ovate, narrowly to widely elliptic, margin recurved, aculeate. *Petiole* 3–38 mm long, with ascending pilose-villous grey-hyaline hairs, occasionally pilose-aculeate. *Lamina* 19–149 mm long, 14.5–96.0 mm wide, adaxial surface scabrid–aculeate, abaxial surface grey pilose-villous, occasionally with mid and lateral veins aculeate. *Lateral* veins 4–10 pairs, 44°–90°, basal veins 29°–75°. *Stipules* 4–10 mm long. *Syconia* 6.8–16.5 mm long, 6–18 mm in diameter, pilose-villous, aculeate. *Peduncle* 2.5–8.5 mm long, occasionally sessile. (Figure 1 A, B)

Selected specimens examined. WESTERN AUSTRALIA: Creek 95 km N of Halls Creek on road to Turkey Creek, 17° 32' S, 127° 54' E, *Aplin, T.E.H.* 358 *& Cranfield, R.J.*, 24 Apr. 1985 (PERTH); 43.5 km by road SW of Bedford Downs Homestead, 65 km W of Great Northern Highway, 92 km NNW of Halls Creek, 17° 15' S, 127° 27' E, *Beauglehole, A.C.* 53731, 23 June 1976 (PERTH); Lake Argyle, S of Kununurra, 16° 01' 48" S, 128° 46' 42" E, *Dixon, D.J.* 452 *& Champion, I.G.*, 23 Dec. 1997 (DNA); Base of the Northern Carr Boyd ranges, bordering the Ord River, 15° 58' S, 128° 43' E, *Hartley, T.G.* 14421, 10 Mar. 1978 (CANB, PERTH); Cracticus Falls, Drysdale River National Park, N Kimberley, 14° 47' S, 127° 05' E, *Kenneally, K.F.* 4188, 10 Aug. 1975 (PERTH); Forest Creek, Drysdale River National Park, N Kimberley, 14° 39' S, 126° 57' E, *Kenneally, K.F.* 4541, 20 Aug. 1975 (CANB, PERTH); Old Halls Creek, 18° 14' S, 127° 46' E, *Morrison, H.A. s.n.*, 11 June 1970 (PERTH); *c.* 39 km S of the Forrest Creek crossing on the Duncan Highway, near boundary of Ord River and Nicholson River Stations, 17° 44' S, 128° 52' E, *Pullen, R.* 10812, 20 Apr. 1977 (BRI, CANB, MEL, PERTH); Hidden Valley, *c.* 3 km NE of Kununurra, E Kimberley, 15° 47' S, 128° 45' E, *Pullen, R.* 10.863, 25 Apr. 1977 (BRI, CANB, LE, PERTH); S base of Mount King, Durack Range, 17° 20' S, 127° 22' E, *Rodd, A.N.* 2858, 24 Oct. 1974 (NSW); Karunjie Station, Kimberley, 16° 17' S, 127° 12' E, *Rust, D.W.* 53, 01 Nov. 1954 (CANB); Minjiyurrdji, limestone outcrop 1 km S of Bungle Bungle outcamp, 17° 21' S, 128° 21' E, *Scarlett, N.H.* 84.307, 01 July 1984 (MEL, NSW). NORTHERN TERRITORY: DARWIN AND GULF: Sir Edward Pellew Group, 15° 44' S, 136° 37' E, *Craven, L.A.* 3712, 08 Feb. 1976 (CANB); Borroloola Township, 16° 03' S, 136° 18' E, *Craven, L.A.* 4134, 05 June 1976 (CANB); 10 km N of Jim Jim Falls, 13° 11' S, 132° 50' E, *Craven, L.A.* 6082, 29 May1980 (CANB); Koolatong River Floodplain near mouth, 13° 13' 33" S, 135° 54' 01" E, *Cowie, I.D.* 7357, 17 Oct. 1996 (BRI, DNA); 44 km SE Oenpelli, 12° 34' S, 133° 23' E, *Dunlop, C.R.* 4934, 15 June 1978 (DNA, NSW); near head of Kilgour River, 16° 45' S, 136° 01' E, *Hill, G.F.* 554, 02 Nov. 1911 (MEL); Wessel Islands, 11° 11' S, 136° 44' E, *Latz, P.K.* 3247, 29 Nov. 1972 (CANB, K); Nitmiluk National Park, Edith Falls area, 14° 09' 36" S, 132° 11' 28" E, *Michell, C.R.* 4158, 09 May 2002 (BRI, DNA); Flying Fox Creek campsite, where track to camp leaves main road, 14° 10' 06" S, 133° 44' 06" E, *Muir, C. s.n.*, 28 July 1993 (DNA, MEL); Nangalala (White Star Landing), 12° 18' S, 134° 59' E, *Reeve, H.* 190, 19 May 1972 (CANB); Groote Eylandt, 1 km S of mouth of the Emerald River, 14° 06' S, 136° 26' E, *Russell-Smith, J.* 2899 *& Lucas, D.*, 23 July 1987 (DNA, MEL); Baniwurruldalk, Croker Island, 11° 06' S, 132° 33' E, *Russell-Smith, J.* 3639 *& Lucas, D*, 07 Oct. 1987 (BRI, DNA); 14 km N of Mataranka on Stuart Highway, 14° 50' S, 132° 58' E, *Tindale, M.D.* 6079 *& Dunlop, C.R.*, 09 July 1979 (NSW); Yambarran Range, 19 km NE Mount Millik, 15° 05' 15" S, 130° 28' 45" E, *Walsh, N.G.* 3832 *& Leach, G.J.*, 15 May 1994 (DNA, MEL); Numbulwan Mission, Rose River, via Darwin, 14° 17' S, 135° 44' E, *Webb, L.J.* 10277 *& Tracey, G.J.* (CANB); 16 Mile Cave Reserve, S of Katherine, 14° 32' S, 132° 15' E, *Webb, L.J.* 12272 *& Tracey, G.J.*, 01 May 1978 (BRI, CANB, DNA). BARKLY TABLELANDS: Settlement Creek, 17° 18' S, 137° 47' E, *Brass, L.J.* 259, 01 Jan. 1923 (CANB); Old Kiana Homestead Spring, 17° 07' S, 136° 02' E, *Russell-Smith, J.* 6234 *& Lucas, D.*, 29 Oct. 1988 (DNA). VICTORIA RIVER: Gregory National Park, near Matt Wilson Creek, 15° 31' 38" S, 131° 08' 36" E, *Cowie, I.D.* 9188 *& Smith, R.*, 05 May 2001 (B, BRI, DNA, MEL). QUEENSLAND: COOK: Horn Island, 10° 35' S, 142° 15' E, *Cameron, E.* 2023, 23 July 1975, (QRS); Edward River Aboriginal Reserve, 26.8 km S of Edward River, Musgrave road on track to Bull Crossing, 14° 59' S, 141° 42' E, *Clarkson, J.R.* 3553, 13 Oct. 1980 (BRI, K, L, MO, PERTH, QRS); Forty Mile Scrub, 18° 07' S, 144° 50' E, *Cooper, W.* 1648 *& Cooper, W.*, 13 Jan. 2002 (QRS); State Forest Reserve 185, Platypus Logging Area, 17° 09' S, 145° 34' E, *Gray, B.* 2606, 01 June 1982 (QRS); W side of Cape York road ± 3 km N of turnoff near Bamaga, 10° 52' S, 142° 24' E, *Jobson, P.C.* 755 *& Power, G.C.*, 27 Aug. 1989 (BRI, MEL); Davies Creek, Mareeba, 17° 01' S, 145° 34' E, *Jones, W.T.* 1326, 24 Aug. 1959 (CANB); Stannary Hills turnoff, 19 km from Herberton, 17° 20' S, 145° 13' E, *Smith, L.S.* 11248, 13 Sep. 1960 (DNA); Near Galbraith, 16° 20' S, 141° 30' E, *Whitehouse, F.W. s.n.*, 01 Jan. 1946 (BRI). BURKE: Karumba, 17° 29' S, 140° 50' E, *Blake, S.T.* 15134, 14 Aug. 1943 (BRI); Between Tully and Massacre Inlets, Gulf of Carpentaria, 16° 12' S, 138° 10' E, *Hyland, B.P.M.* 13571, 22Aug. 1988 (QRS); Doomadgee, 17° 56' S, 138° 49' E, *Fawssett, L.* 41, 11 Aug. 1961 (BRI); Duchess Road, 6.8 km S of Mount Isa (by air), 20° 47' 06" S, 139° 29' 57" E, *Fraser, A.* 251, 14 Nov. 1997 (CANB, DNA); Lagoon Creek, 17° 33' S, 138° 06' E, *Melville, S.* 1056, 24 June 1990 (BRI); Sweers Island, 17° 06' S, 139° 37' E, *Mueller, F.J.H.* 2, (L, MEL); Near Morestone Station, 19° 32' S, 138° 22' E, *Perry, R.A.* 1027, 28 May 1948 (CANB, MEL); Armraynald Station, W of the Leichhardt River and *c.* 40 km SE of Burketown, 17° 57' S, 139° 46' E, *Pullen, R.* 8955, 28 Apr. 1974 (BRI, CANB); Adels Grove, near Lawn Hill Creek, 18° 41' S, 138° 32' E, *Rodd, A.N.* 3204, 23 May 1976 (BRI, NSW); Murrays Spring, 12 km by road W of Musselbrook mining camp, 175 km N of Camooweal, 18° 35' S, 138° 02' E, *Thomas, M.B.* MRS61C *& Johnson, R.W*, 24 Apr. 1995 (BRI, DNA); Normanton, 17° 40' S, 141° 04' E, *Waterhouse, B.M.* 5131, 22 Mar. 1999 (BRI, DNA); Cloncurry, 20° 42' S, 140° 30' E, *Blake, S.T.* 10129, 08 Nov. 1935 (BRI).

Distribution. A widespread variety of *Ficus aculeata* occurring from Cape York in Queensland across tropical Australia to the Kimberley region and south to the Pilbra region of WA. (Figure 2)

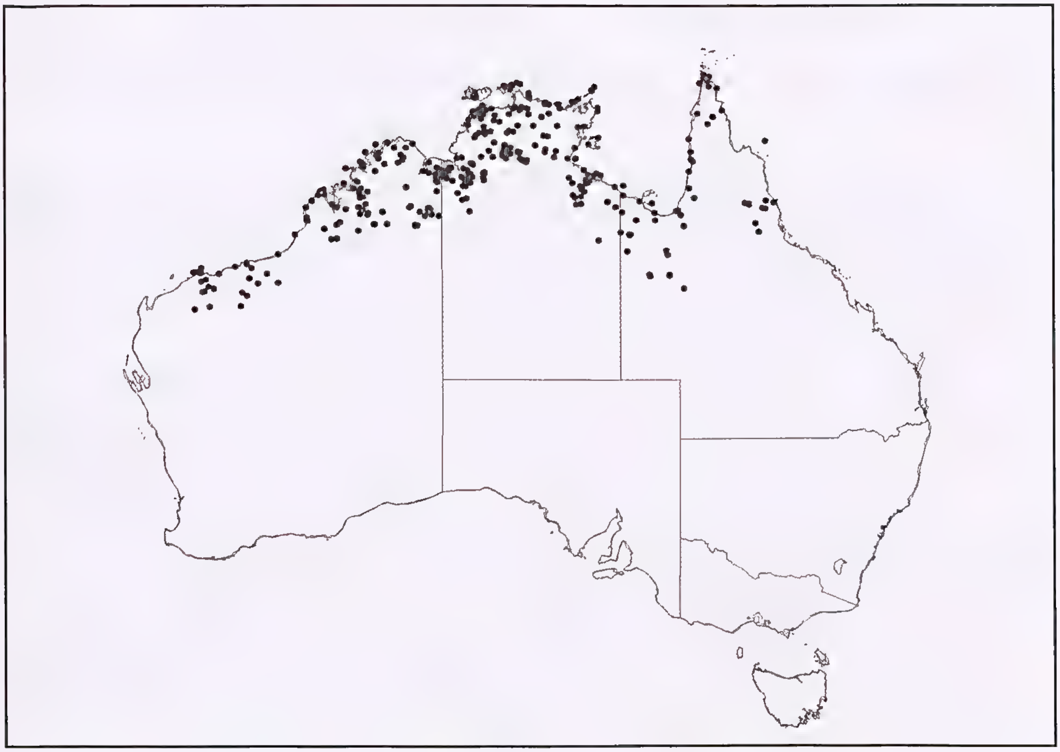

Figure 2. The distribution of *Ficus aculeata* var. *aculeata* based on available collection data.

Habitat. Ficus aculeata var. *aculeata* has diverse habitat preferences and has been recorded from hummock grassland, riparian forest, eucalypt woodland, vine thickets, *Melaleuca* shrubland and woodland, *Allosyncarpia* forest, and floodplain margins. It is most commonly encountered in eucalypt woodland. No particular substrates are favoured with records indicating that the variety has been found on alluvium, loams, and heavy clay soils, coastal sand and calcareous dunes, and soils derived from granite, limestone, laterite, quartz, and basalt.

Affinities. This variety could be confused with *Ficus opposita* where the two co-occur, however, vegetative characters allow for easy identification. *Ficus aculeata* var. *aculeata* has a dense covering of whitish pilose hairs on the abaxial surface that obscure the lamina surface and the sunken areolae. *Ficus opposita* can have a dense covering of soft pilose hairs, but these are never as intensely white as in var. *aculeata*, and the areolae are never sunken. The margin of var. *aculeata* is often harshly aculeate. The trilobed condition found commonly in *Ficus opposita* from the east coast is a results from regrowth after damage sustained to an individual and has never been recorded from *F. aculeata* and its two varieties.

Pollinator wasp. The pollinator wasp species is unknown.

Ficus aculeata var. **indecora** (Miq.) D.J. Dixon, *stat. et comb. nov.*

Basionym: Ficus indecora Cunn. ex Miq., *London J. Bot.* 7: 426 (1848); *Ficus opposita* var. *indecora* (Cunn. ex Miq.) Corner, *Gard. Bull. Singapore* 17: 471 (1959). *Type*: Careening Bay, [WA.], *A. Cunningham* (*holo*: K; *iso*: BM; U).

Ficus orbicularis Miq. *London J. Bot.* 7: 426 (1848). *Type*: North West Coast [WA.], *Cunningham* (*lecto*: K, here designated; *isolecto*: U).

Ficus beckleri Miq. *J. Bot. Neerl.* 1: 241 (1861). *Type*: Fitzmaurice River, Arnhemland, [NT], *Beckler* (*holo*: U; *iso*: L).

Twigs with ascending puberulous, scabrid hairs, glabrescent. *Leaves* widely to narrowly elliptic, ovate, occasionally obovate, margin recurved, rarely flat, aculeate. *Petiole* 2.5–25.0 mm long, scabrid or with ascending puberulous hyaline hairs. *Lamina* 17–182 mm long, 13–81 mm wide, adaxial surface smooth, scabrid, abaxial surface scabrid along mid and lateral veins. *Lateral* veins 4–13 pairs, 31°–57°, basal veins 43°–83°. *Stipules* 5.5–15.0 mm long. *Syconia* 7–14 mm long, 6.0–13.5 mm in diameter, scabrid, aculeate, occasionally pilose. *Peduncle* 2–10 mm long. (Fig. 1, C & D)

Selected specimens examined. WESTERN AUSTRALIA: Windjana Gorge, Lennard River, Napier Range, 17° 19' S, 124° 48' E, *Beauglehole, A.C.* 11223, 04 Aug. 1965 (MEL, PERTH); Broome, new jetty area, 17° 58' S, 122° 14' E, *Beauglehole, A.C.* 11239, 07 Aug. 1965 (MEL, PERTH); Cape Bossut, 18° 42' S, 121° 37' E, *Butler, W.H. s.n.*, Aug.1963 (PERTH); *c.* 7 miles S of Yarrie, 20° 46' S, 120° 12' E, *Demarz, H.* 5731, 16 Oct. 1975 (PERTH); Mount Hart Homestead on Barker River, NW Kimberley, 16° 50' S, 124° 55' E, *Edinger, D.J.* 458, 24June 1987 (PERTH); Goody Goody, 17° 20' S, 123° 44' E, *Fitzgerald, W.V.* 258, Apr. 1905 (PERTH);Near Goose Hill, E Kimberley, 15° 34' S, 128° 21' E, *Fitzgerald, W.V.* 1598, Sep. 1906 (PERTH); De Grey River, 20° 21' S, 119° 20' E, *Gardner, C.A.* 8070, Sep. 1946 (PERTH); King Sound, 17° 10' S, 123° 30' E, *Hughan, A. s.n.*, (MEL); Walcott Inlet, 16° 27' S, 124° 50' E, *Hyland, B.P.M.* 13559, 18 June 1988 (PERTH, QRS); Between Lombadina Mission and Pender Bay, Dampier Peninsula, W Kimberley Coast, 16° 37' S, 122° 50' E, *Kenneally, K.F.* 6207, 28 Apr. 1977 (PERTH); Fenelon Island off Admiralty Gulf, N Kimberley Coast, 14° 08' S, 125° 42' E, *Kenneally, K.F.* 6409, 27 July 1977 (CANB, K, PERTH); Hearson Cove, Burrup Peninsula, 20° 38' S, 116° 48' E, *Kenneally, K.F.* 7296, 23 July 1980 (PERTH); Kalumburu, 14° 17' S, 126° 38' E, *Reim, H.* 18, Oct. 1968 (PERTH); Ripon Hills, 36 km S of Warrawagine Homestead, *c.* 80 km SE of Shay Gap, 21° 09' 00" S, 120° 45' 35" E, *Newbey, K.R.* 10517, 15 July 1984 (PERTH); Legendre Island, Dampier Archipelago, 20° 23' S, 116° 52' E, *Royce, R.D.* 7325, 10 June 1962 (PERTH); Tickalara Track, ± 2.5 km S of Bungle Bungle outcamp near crossing of unnamed ephemeral creek, SE Kimberley, 17° 22' S, 128° 20' E, *Scarlett, N.H.* 84-323, 01 July 1984 (PERTH); Harding River, Large pool below Lockyer's Pool, 20° 59' S, 117° 07' E, *Weston, A.S.* 12774, 15 Sep. 1981 (PERTH); On Diamond field track near Ellendale Station, W Kimberley, 17° 39' S, 124° 55' E, *Willing, T.* 132, 21 Sep. 1984 (BRI, PERTH); Coronation Island, Bonaparte Archipelago, 15° 00' S, 124° 55' E, *Wilson, P.G. s.n.*, 23 May 1972 (PERTH). NORTHERN TERRITORY: DARWIN AND GULF: Adelaide River, 13° 14' S, 131° 07' E, *Blake, S.T.* 16689, 06 Aug. 1946 (BRI); Holmes Jungle, 12° 24' S, 130° 55' E, *Booth, R.* 245, 06 Jan. 1995 (DNA); Mann River, near Gamarrgawan outstation, 12° 42' 01" S, 134° 03' 21" E, *Brennan, K.G.* 3575, 13 Nov. 1997 (DNA); Kapalga, 12° 35' S, 132° 25' E, *Collins, R.* 64, 31 July 1976 (DNA); Bradshaw Creek area; 10 km NE Dorisvale, 14° 28' S, 131° 24' E, *Cousins, S.N.* 43, 30 Nov. 1978 (DNA, NT); Adelaide River scenic drive off Stuart Highway, 186 km N of Katherine, 13° 25' 53" S, 131° 10' 20" E, *Dixon, D.J.* 468 *& Champion, I.G.*, 28 Oct. 1996 (DNA); Finniss River Station, 12° 52' 04" S, 130° 21' 17" E, *Harwood, R.K.* 171 *& Mangion, C.P.*, 19 Aug. 1997 (DNA); Smith Point, Cobourg Peninsula, 11° 10' S, 132° 10' E, *Must, J.* 832, 08 Oct. 1971 (DNA, L); Horns Creek, 12° 36' S, 131° 06' E, *Rankin, M.O.* 1540, 08 Nov. 1978 (DNA); Pioneer Beach area, 12° 41' S, 130° 37' E, *Rankin, M.O.* 2224, 06 May 1979 (DNA); Daves Point Area Woolner Station, 12° 19' S, 131° 31' E, *Rankin, M.O.* 2499, 25 June 1980 (DNA); Fountain Head Sidings, 13° 28' S, 131° 28' E, *Robinson, C.S.* 618, 23 June 1964 (DNA); Flora River Conservation Reserve, 14° 45' 42" S, 131° 36' 03" E, *Short, P.S.* 4609 *& Dunlop, C.R.*, 09 Oct. 1996 (DNA); 4 km E of Jim Jim turnoff on Arnhem Highway, 12° 58' S, 131° 55' E, *Webb, L.J.* 12269 *& Tracey, G.J.*, 01 May

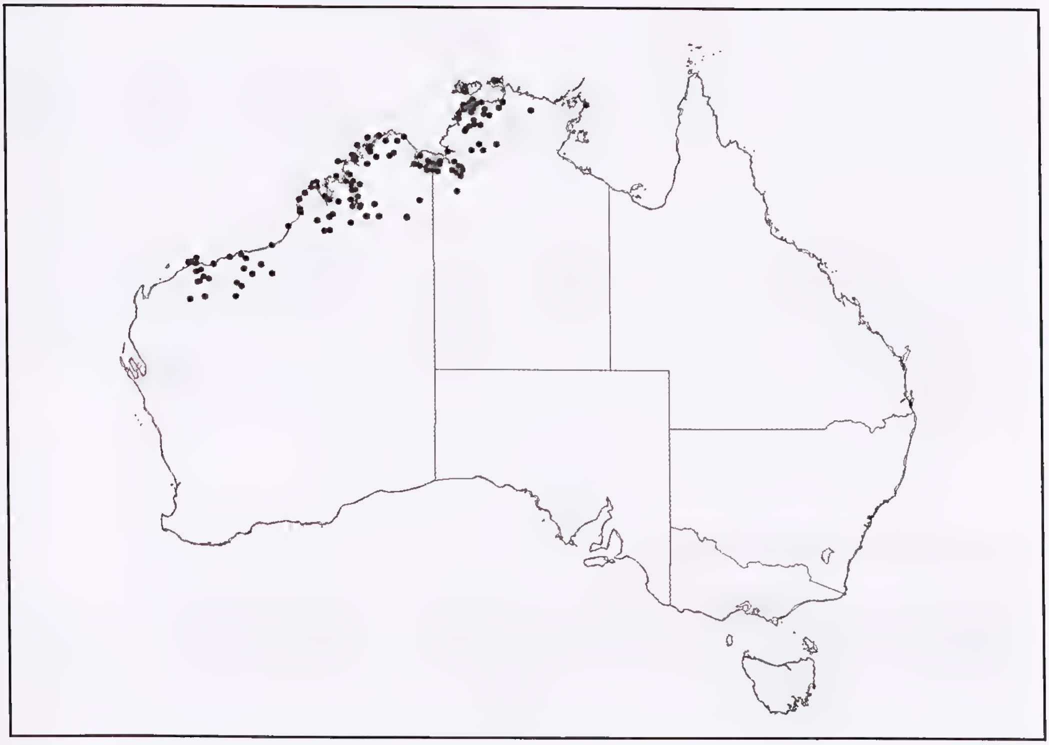

Figure 3. The distribution of *Ficus aculeata* var. *indecora* based on available collection data.

1978 (BRI); Melville Island, Fort Dundas, 11° 46' S, 130° 40' E, *Wightman, G.M.* 2951, 29 May 1986 (DNA); Daly River Mission Area, 13° 40' S, 130° 43' E, *Wightman, G.M.* 5266, 03 Apr. 1991 (DNA). VICTORIA RIVER: Gregory National Park; adjacent to Wickham River, 16° 51' 27" S, 130° 13' 52" E, *Cowie, I.D.* 7774, 05 June 1998 (DNA); Augustus waterhole on road to Spirit Hills from Kununurra, 15° 28' 39" S, 129° 15' 27" E, *Dixon, D.J.* 935 *& Kerrigan, R.A.*, 25 Oct. 2001 (B, DNA); Gregory National Park, Drovers Rest, 15° 55' S, 130° 15' E, *Wightman, G.M.* 6819, 17 Oct. 1996 (DNA); Bradshaw Station; Barramundi Pump, 15° 20' S, 130° 06' E, *Wightman, G.M.* 6966, 03 June 1997 (DNA).

Distribution. Ficus aculeata var. *indecora* occurs predominantly on the western side of the top end of the NT, across to the Kimberley region and south to the Pilbara region of WA. There is one collection from the Gove area of eastern Arnhem Land. (Figure 3)

Habitat. Open eucalypt woodland, deciduous vine thicket, grassland, riverine vegetation, Pindan, and *Melaleuca* woodland are the frequently recorded habitats of this taxon. A large number of collections have been collected from laterite formations, or soils derived from laterite. Other substrates from which this variety has been collected include sandstone, cracking clays, loams, basalt, limestone, dolomite, bauxite, sand and calcareous coastal dunes, and heavy soils fringing saline areas.

Typification. Two sheets, one housed at K, the other at U, compete for type status for *Ficus orbicularis* Miq. As was Miquel's practice, a leaf was retained at his home institution and hence the U sheet consists of a single leaf and a bag containing fragments of a syconium. The K sheet consists of four leafy twigs and associated labels. One twig (top left hand corner) bears a label in Miquel's hand, the Hb. Hook. 1867 stamp and a tag in Cunningham's hand indicating his manuscript name and the collection locality. Presumably Professor Corner delineated this portion of the K sheet as the type although his annotation slip does not indicate this. I am accepting this element of the K sheet as the holotype even though another of Allan Cunningham's labels with North West Coast (N.W.C.) is in the bottom left corner. These elements are excluded as there is a another Cunningham label giving a further location as Enderby Island, Dampier Archipelago. Given the fact that Miquel cited more precise localities when they were available on the specimen (see type details of *Ficus indecora*), I find it impossible to believe that he would not have cited the Enderby Island element in the protologue if he had indeed seen it.

Affinities. This variety can be easily distinguished from var. *aculeata* by the absence of hairs obscuring the sunken areolae. The orifice of the areola may be fringed with hairs, but the leaf surface is never obscured by hairs as in var. *aculeata.* Material treated as *Ficus scobina* Benth., by Wheeler (1992) in the Flora of the Kimberley Region is actually *F. aculeata* var. *indecora*. *Ficus scobina* is endemic to the NT. The leaf (*Hyland, B.P.H.*, 25507) and florets (*Hyland, B.P.H.*, 25438) images provided by Hyland *et al.* (2003) under *Ficus opposita* var. *indecora* are *F. aculeata* var. *indecora.*

Pollinator wasp. The pollinator of *F. aculeata* var. *indecora* is unknown.

Ficus carpentariensis D.J. Dixon, *sp. nov.*

Species Fico aculeato affinis sed ea venatione elevata reticulata in pagina abaxiali folii, areolas depressas Fici aculeatae non habens, pilis aculeatis in margine folii destituta, pedunculo gracili synconii, folio coriaceo (F. aculeata folia crustacea habet) distinguenda; ad ripas fluviorum.

Typus: 30 km N of Ngukurr, 14° 24' S 134° 43' E, 25 November 1987, *Russell-Smith, J.* 4168 *& Lucas, D.* (*holo:* DNA; *iso:* MEL, NSW).

A species with affinities to *Ficus aculeata* Miq. from which it can be distinguished by the raised reticulate venation on the abaxial leaf surface compared to the sunken areola of *F. aculeata*, the lack of aculeate hairs on the leaf margin, the slender peduncle of the syconium, the coriaceous texture of the leaf compared to the crustaceous texture of *F. aculeata*.

Tree to 12 m, dioecious. *Twigs* solid, with ascending puberulous-pilose hyaline hairs, occasionally scabrid, glabrescent. *Leaves* opposite or alternate, narrowly elliptic to elliptic, margin recurved, aculeate or smooth, apex acute, base cuneate, oblique, rounded, obtuse, occasionally truncate. *Petiole* 6.0–22.5 mm long, with ascending puberulose-pilose hyaline hairs, occasionally scabrid, channeled on the upper surface, flat gland present at junction of petiole and lamina. *Lamina* 42–188 mm long, 16.5–65.0 mm wide, adaxial surface scabrid, occasionally aculeate, abaxial surface scabrid, puberulous-pilose, occasionally villous, with raised reticulate venation, cystoliths visible as raised dots on adaxial surface, coriacous. *Lateral* veins 11–18 pairs, 49°–72°, basal veins 33°–53°. *Stipules* to 12 mm long, with puberulous-pilose appressed hyaline hairs, caducous. *Syconia* axillary, globular, 11–21 mm long, 10–11.5 mm in diameter, puberluous-pilose, occasionally villous. *Basal* bracts 3, with puberulous hyaline hairs, persistent, occasionally evenly spaced along peduncle. *Peduncle* 6.5–14.0 mm long. *Male* florets ostiolar in 1 or 2 rows, pedicellate with 4 or 5 tepals. *Stamens* one. *Female* and gall florets sessile and pedicellate, with 5 or 6 tepals. *Interfloral* bracts absent. (Figure 1 E, F)

Specimens examined. NORTHERN TERRITORY: DARWIN AND GULF: Kakadu National Park, Koolpin Gorge day use area, 13° 29' 55" S, 132° 34' 23" E, *Brennan, K.G.* 1602, 20 Nov. 1991 (DNA); Abner Range; 6 km NE of Cape Crawford Hotel, 16° 41' S, 135° 47' E, *Brock, J.* 486, 29 Jan. 1989 (DNA); 20 km W of Wollogorang Homestead, Plot 1418, 17° 12' 02" S, 137° 42' 34" E, *Harwood R.K.* 536, 30 Sep. 1998 (DNA); Elsey National Park, Botanical Walk, 14° 56' 27" S, 133° 08' 19" E,

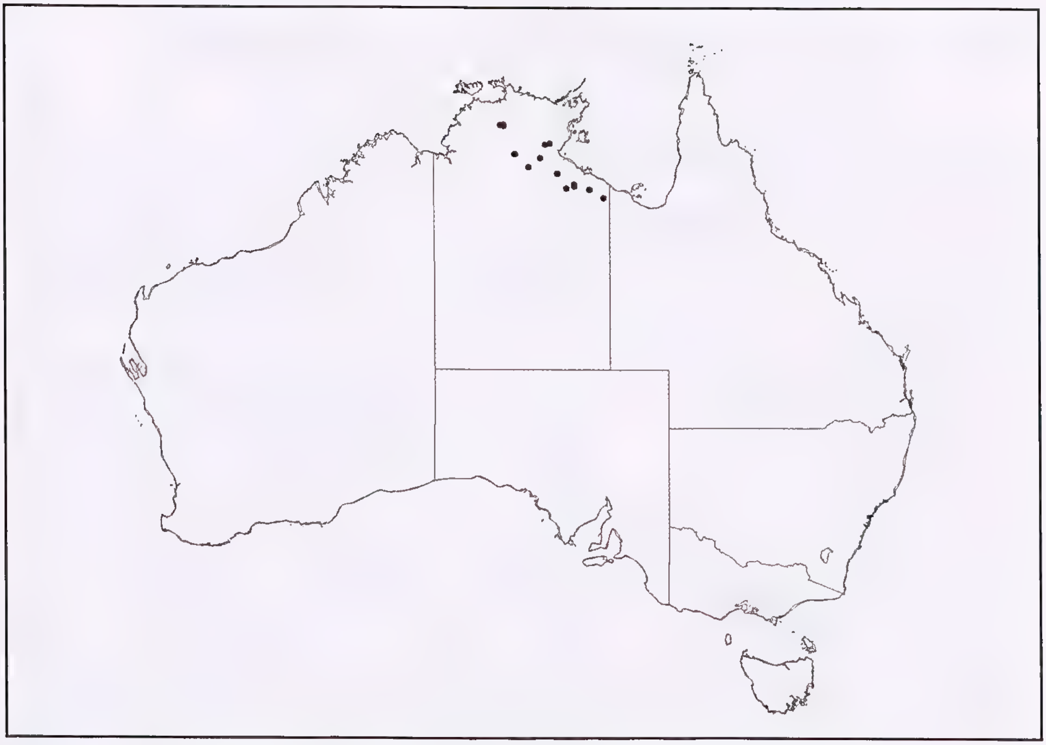

Figure 4. The distribution of *Ficus carpentariensis* based on available collection data.

Leach, G.J. 3918, 30 Nov. 1993 (BRI, CANB, DNA); Koolpin Creek, 13° 29' S,132° 25' E, *Rankin, M.O.* 1612, 28 Nov. 1978 (CANB, DNA, MEL); 30 km N of Ngukurr, 14° 28' S, 134° 43' E, *Russell-Smith, J.* 4168, 25 Nov. 1987 (DNA, NSW, MEL); 1 km SW of Angus Spring, Hodgson Downs, 15° 08' S, 134° 27' E, *Russell-Smith, J.* 6650 & *Lucas, D.*, 17 Jan. 1989 (BRI, DNA, K, MEL); Robinson River Station, Nunns Spring, 16° 45' S, 136° 58' E, *Wightman, G.M.* 5452, 16 Aug. 1991, (DNA).

Distribution. Ficus carpentariensis is endemic to the Northern Territory, Australia. (Figure 4)

Habitat. It is frequently associated with riparian vegetation or monsoon forest associated with sandstone.

Conservation status. Ficus carpentariensis has been evaluated as least concern under the IUCN guidelines. It is relatively widespread in the NT and is expected to be more common than current collections indicate.

Etymology. The epithet is in reference to this species proximity to the Gulf of Carpentaria.

Affinities. Ficus carpentariensis is an uncommonly collected species closely related to *Ficus aculeata*. It can be distinguished from *F. aculeata* by the narrowly elliptic to elliptic leaves, the longer peduncle of the syconium, and the raised reticulate venation as opposed to the sunken areolae of *F. aculeata*. *Ficus aculeata* is predominantly a woodland species, while *F. carpentariensis* is associated with riparian and monsoon forests.

Notes. This species has previously appeared on the NT checklist of vascular plants as *Ficus* D17207 Roper River, *Ficus* D17207 *carpentariensis* and *Ficus* sp. *carpentariensis* (W.B. Spencer 01/Jul/11).

Pollinator wasp. The pollinator wasp of *F. carpentariensis* has not been collected.

Ficus opposita Miq. *London J. Bot.* 7: 426 (1848). *Type:* Bremer River, [Qld], 1829, *C. Fraser* 101 (*holo*: K; *iso*: U).

Ficus fitzalanii Miq. *J. Bot. Neerl.* 1: 242 (1861). *Type:* Cape Cleveland, Qld, *E. Fitzalan s.n.* (*holo:* U).

Ficus conjugata Miq. *Ann. Mus. Bot. Lugd. Bat.* 3: 222 (1867). Type: Java, *De Vriese s.n.* (*holo:* U, photo seen).

Ficus xerophila Domin, *Biblioth. Bot.* 89: 14 (1921). *Type:* Smelling Bluff, near Chillagoe, Qld, ii.1910, *K. Domin. s.n.* (*holo:* PR).

Ficus yarrabensis Domin, *Biblioth. Bot.* 89: 15 (1921). *Type:* Yarraba, Qld, i.1910, *K. Domin. s.n.* (*holo:* PR).

Ficus apolepomena Summerh. *J. Arnold Arb.* 10: 151 (1929). *Type:* Bisiatabu, New Guinea, 6/xi/1925, *L.J. Brass* 575 (*holo:* K; *iso:* BRI, photo seen).

Ficus branderhorstii Diels, *Bot. Jahrb. Syst.* 67: 201 (1936). *Type:* Kabatiel, Southern New Guinea, 6.xii.1907, *Branderhorst* 257 (*holo:* K; *iso:* L photo seen, ?BO).

Tree to 15 m, dioecious. *Twigs* solid, with ascending scabrid-aculeate, puberulous-pilose, hyaline hairs, glabrescent. *Leaves* opposite or alternate, sometimes both conditions occurring on same individual, ovate, slightly obovate, oblique, elliptic, lanceolate, (trilobed on regrowth), margin recurved, revolute, aculeate, dentate-glandular, entire; apex acute, rounded, obtuse; base oblique, rounded, obtuse, cordate. *Petiole* 6–48 mm long, aculeate, scabrid or with ascending puberulous-pilose hyaline hairs, occasionally pilose-aculeate, glabrescent or occasionally glabrous, shallowly channeled on the upper surface. *Lamina* 33–237 mm long, 15–108 mm wide, adaxial surface smooth, scabrid, scabrid–aculeate,

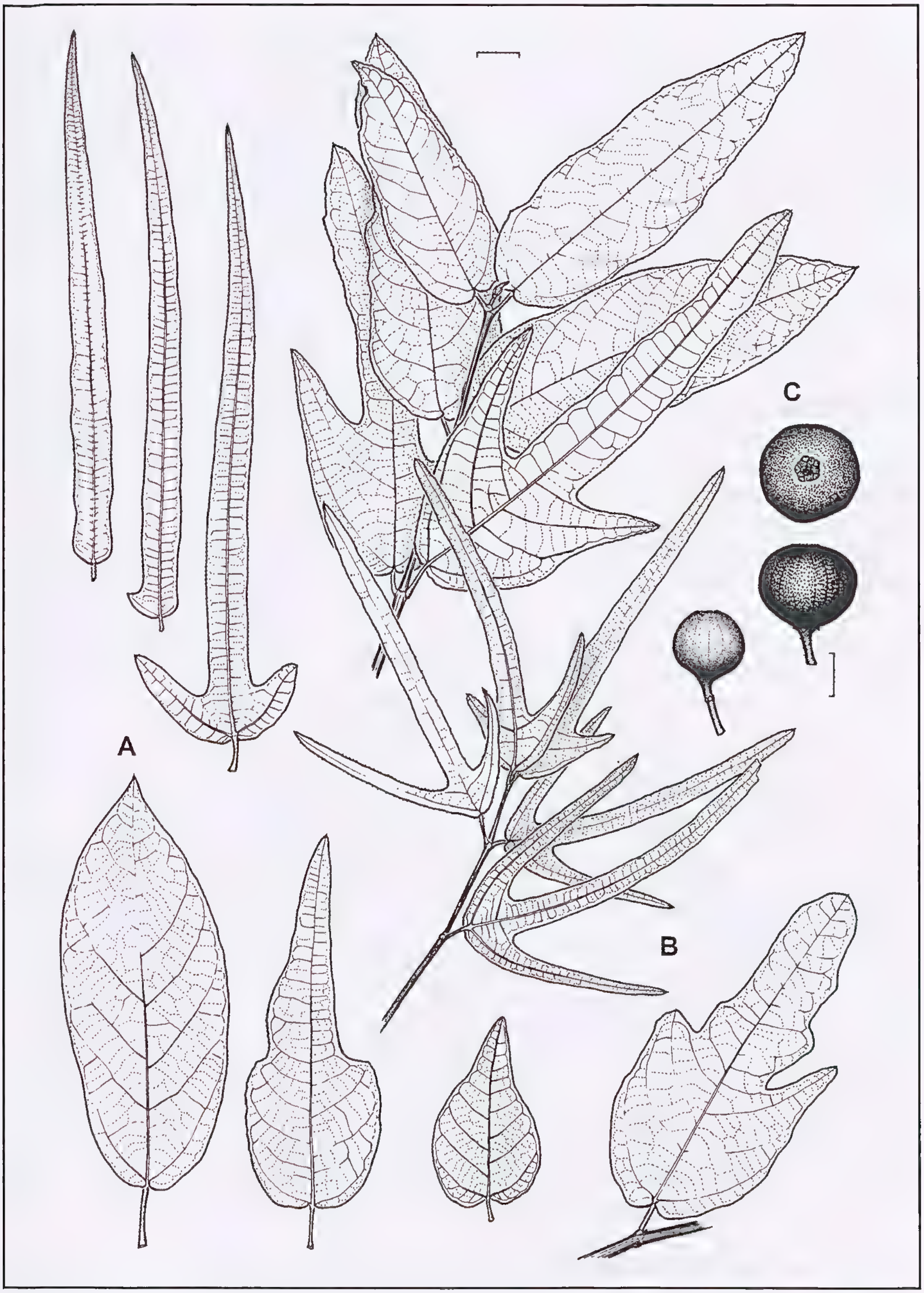

Figure 5. A–C. *Ficus opposita*. A – six leaves showing variation evident on one specimen (*Bancroft, E.J.* 1654; NSW); B – Leafy twigs showing transition from trilobed to typical leaf shape (Dixon, D.J. 382, DNA). C – Syconia, top two (*Dixon, D.J.* 6, DNA), bottom syconium showing stipitate form (*Dixon, D.J.* 10, DNA). Scale bar A and B = 2 cm. Scale bar C = 1cm.

pilose, occasionally puberulous-pilose along mid and lateral veins, glabrescent, occasionally glabrous; abaxial surface scabrid, scabrid-aculeate, sometimes only along mid and lateral veins, puberulous-pilose; cystoliths visible as raised dots on adaxial surface, crustaceous. *Lateral* veins 4–13 pairs, 40°–78°, basal veins 26°–74°. *Stipules* 7–14 mm long, with puberulous-pilose appressed hyaline hairs, caducous. *Syconia* axillary, ramiflorous, broadly ovoid, occasionally constricted above basal bracts making peduncle appear longer, 8.8–19.2 mm long, 11.0–22.5 mm in diameter, scabrid, pilose, aculeate. *Female* plants with dark maroon-red fleshy syconia; male plants with green and maroon-red striped dry syconia at maturity. *Basal* bracts 3, with puberulous-pilose hyaline hairs, persistent or caducous, occasionally one becoming lateral on the wall of the syconium. *Peduncle* 0.0–10.0 mm long. *Male* florets ostiolar, pedicellate with 4–6 tepals. *Stamens* one. *Female* and gall florets sessile and pedicellate, with 3–5 tepals. *Interfloral* bracts absent. (Figure 5)

Selected specimens examined. PAPUA NEW GUINEA: Sudest Island, Joe Landing., *Brass, L.J.* 27720, 17 Aug. 1956 (L, LAE); West Point, Sudest Island, Milne Bay District, *Henty, E.E.* 27105, 8 Nov. 1965 (A, BO, BRI, CANB, K, L); Brown River, Port Moresby., *Kairo, A.* 35621 *& Streimann, H.*, 3 Jan. 1967 (A, BISH, BO, BRI, CANB, K, L); Goragatabu Creek area, 15 miles N of Port Moresby, Central District, *Pullen, R.* 6758, 18 Apr. 1967 (CANB, L, LAE); Nazareth Mission, Laloki River, Port Moresby sub-district, Central District, *Streimann, H.* 51639 *& Kairo, A.*, *s.dat.* (A, BISH, BRI, CANB, K, L, NSW, PNH, SING, US). QUEENSLAND; COOK: Melville Range, *c.* 11 km SSW of Cape Melville, 14° 16' S, 144° 27' E, *Clarkson, J.R.* 5420, 10 June 1984 (BRI, L, NSW, QRS); 27.3 km along Mount Windsor road, 16° 18' S, 145° 05' E, *Dixon, D.J.*, 365, 9 Dec. 1996 (DNA); Mungana National Park, NW of Chillagoe, 17° 05' S, 144° 23' E, *Forster, P.I.* PIF18591 *& Ryan, T.*, 14 Feb. 1996 (QRS). BURKE: 5 km NW of Stirling Station, 103 km NE of Normanton, 17° 11' S, 141° 42' E, *Ollerenshaw, P.* 1470 *& Kratzing, D.*, 16 July 1974 (BRI, CANB, MO). NORTH KENNEDY: Great Basalt Wall, Southwick, 19° 54' S, 145° 37' E, *Fensham, R.J.* 18, 7 June 1992 (BRI); Taravale near Hell Hole Creek, 0.5 km E of Homestead, 19° 07' S, 146° 05' E, *Jackes, B.R.* 8749, 22 Mar. 1987 (BRI); Proserpine River, 7 km ESE of Proserpine, 20° 25' S, 148° 38' E, *Sharpe, P.R.* 4203, 11 Nov. 1985 (BRI). SOUTH KENNEDY: 55 km SW of Sarina on Wandoo Station at the confluence of Three-mile Creek and Funnel Creek, 21° 43' S, 149° E, *Dixon, D.J.* 85, 26 Jan.1993 (DNA); Slade Point Reserve, off Green Arrow Track, 21° 04' S, 149° 13' E, *Champion, I.G.* 1387, 17 Aug. 1996 (DNA). LEICHHARDT: Bee Creek ex Road to Lake Eliphinstone, 21° 30' S, 148° 14' E, *Dixon, D.J.* 40 *& Champion, I.G.*, 11 Jan. 1996 (DNA). BURNETT: Castle Mountain, *c.* 30 km N of Monto, 24° 39' S, 151° E, *Stanley, T. s.n. & Ross, E.M.*, 1 Nov. 1976 (BRI); *c.* 12 km NW of Ban Ban Springs, 25° 30' S, 151° 40' E, *Olsen, M.* 3527 *& Byrnes, N.B.*, 23 May 1977 (BRI); Mount Perry, near Bundaberg, 25° 12' S, 151° 41' E, *Keys, J.* 177, *s.dat.* (BRI). PORT CURTIS: Pine Mountain, Marlborough Station, 24° 45' S, 149° 50' E, *Batianoff, G.N.* 9805125 *& Ryan, T.*, 14 May 1998 (BRI); Rockhampton, 23° 22' S, 150° 30' E, *Common, I.F.B.* 14, 1 May 1948 (BRI); Great Keppel Island, Big Sandhill Beach, 23° 09' S, 150° 57' E, *Batianoff, G.N.* 9578 *& Dillewaard, H.A.*, 13 Nov. 1987 (BRI); Bundaberg, 24° 52' S, 152° 21' E, *Tenison-Woods, J.E. s.n.*, *s.dat.* (BRI). WIDE BAY: Fraser Island, 25° 15' S, 153° 10' E, *Epps, F.G. s.n.*, 1 Dec. 1919 (BRI). MORETON: Somerset Dam, Kilcoy Road W side of Dam, 27° 04' S, 152° 33' E, *Grimshaw, P.* 47, 21 Oct. 1993 (BRI); Indooroopilly, 27° 30' S, 152° 58' E, *White, C.T. s.n.*, 14 Nov. 1908 (BRI). NEW SOUTH WALES: New England, *Thozet, A.* 130, *s.dat.* (MEL).

Distribution. In Australia *Ficus opposita* is restricted to Queensland but extends north to Papua New Guinea. One specimen from MEL indicates a NSW locality and this is the only record of this species in NSW. I could not place the MEL material (*Thozet* 130) with either of the two sandpaper fig species, *Ficus coronata* Spin and *Ficus fraseri* Miq., that are recorded by Harden (2000) for NSW. It may represent a valid record or an incorrect citation on the label. (Figure 6)

Habitat. Ficus opposita is essentially a woodland species found predominantly in open eucalypt communities and is also commonly encountered in riparian vegetation bordering eucalypt communities. It has also been recorded from deciduous vine thickets, fringes of rain forest and coastal sand dune communities. It has been collected from a variety of soil types including soils derived from basalt, sandstone, granite, limestone, alluvial deposits and serpentine.

Typification. Specimens of *Ficus opposita* Miq., seen by Miquel exist at K and U. The K specimen bears a label in Miquel's hand as well as a tag, presumably in Fraser's hand, that indicates the collection locality, year of collection, name and number. The U specimen is a single leaf and a fragment bag containing an intact syconium. The K specimen is the holotype.

Notes. The leaf image provided by Hyland *et al.,* (2003) under *Ficus opposita* var. *opposita* (*Gray B.*, 4692) is *F. opposita.* The photographs of the male florets (*Gray, B.*, 4776), female florets (*Hyland, B.P.H.*, 13396), transverse section through a syconium (*Gray, B.*, 4515) and female florets (*Gray, B.*, 4515) are *F. opposita.*

Pollinator wasp. The pollinator of *F. opposita* in Australia is *Kradibia nigricorpus* (Girault) and was named apparently from material collected in Queensland (Wiebes 1993).

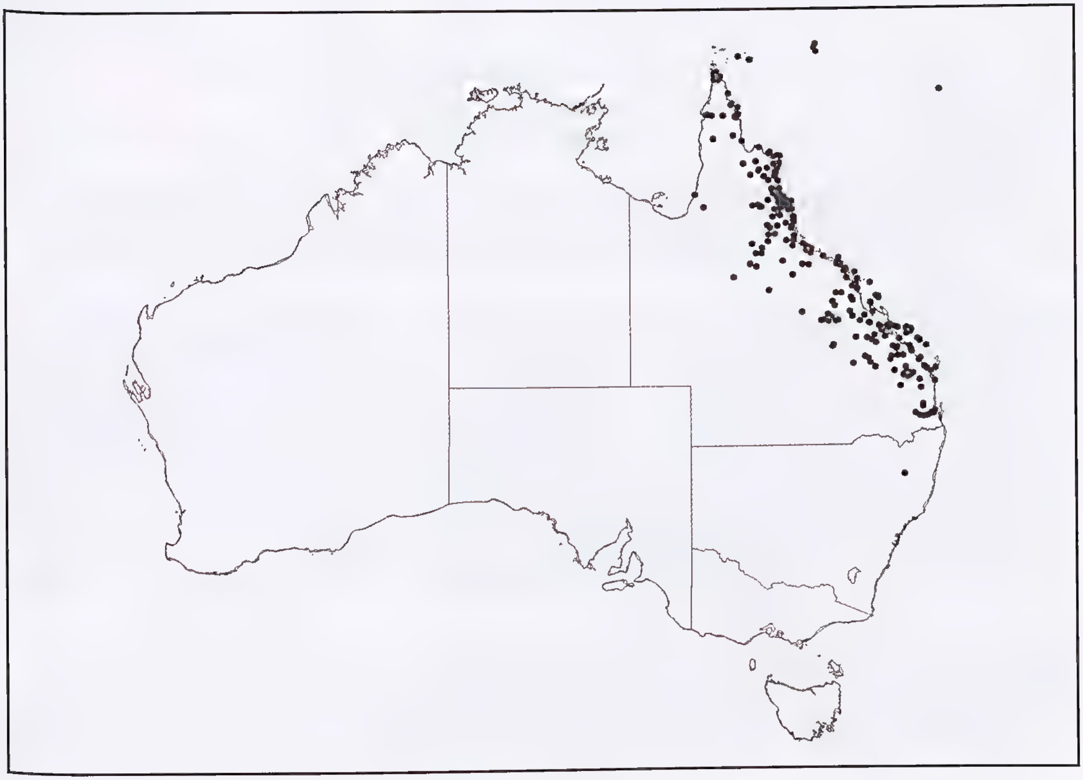

Figure 6. The distribution of *Ficus opposita* in Australia.

Acknowledgements

The following herbaria: BM, BRI, CANB, DNA, K, L, LAE, MEL, NSW, NT, PERTH, PR, QRS, and U kindly provided specimens on loan or bench space during my visits. I thanks the Directors and Staff of these institutions, for without access to these valuable collections this research could not have been completed. I would also like to thank the ABLO, Dr Roberta Cowan who examined material at K and the BM in my effort to find type material. Finally, I would like to acknowledge Monika Osterkamp-Madsen as the illustrator.

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Nuytsia 16(2):285–297 (2007)

A new species and a new combination in *Acrotriche* (Ericaceae: Styphelioideae: Styphelieae), with keys to the Western Australian members of the genus and its closest relative *Lissanthe*

Michael Hislop

Western Australian Herbarium, Department of Environment and Conservation
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983

Abstract

Hislop, M. A new species and a new combination in *Acrotriche* (Ericaceae: Styphelioideae: Styphelieae), with keys to the Western Australian members of the genus and its closest relative *Lissanthe*. *Nuytsia* 16(2): 285–297 (2007). Descriptions, illustrations and distribution maps are given for a new species, *Acrotriche lancifolia* Hislop and its closest relative *A. patula* R.Br. with which it has hitherto been confused. A lectotype is also selected for *A. patula*. A new combination, *A. parviflora* (Stschegl.) Hislop is made. The case is argued for the removal of *A. depressa* R.Br. from the West Australian plant census. Keys are provided at the generic level to separate *Acrotriche* R.Br. from *Lissanthe* R.Br. and at the species level for all Western Australian members of these two related genera.

Introduction

Acrotriche R.Br. is a small, Australian endemic genus first described by Robert Brown (1810). It comprises 17 species which are scattered across southern Australia and as far up the eastern seaboard as north Queensland. Six occur in Western Australia.

Brown originally recognised eight species in his new genus (although *A. ovalifolia* was later reduced to synonymy under *A. cordata*). De Candolle (1839), Mueller (1855), and Bentham (1869) contributed three more names (*A. affinis*, *A. prostrata*, and *A. fasciculiflora* respectively) during the nineteenth century, and two were added (*A. halmaturina* and *A. rigida*) as part of a full revision of the genus by Paterson (1960). Since then three more names have been published – *A. baileyana* and *A. plurilocularis* by Jackes & Powell (1980) and *A. leucocarpa* by Jobson & Whiffin (1990). Recently the anomalous, Western Australian species, *Leucopogon durus* Benth., was also transferred to *Acrotriche* (Quinn *et al.* 2005), as one of a series of taxonomic changes resulting from an extensive molecular and morphological analysis of the phylogeny of the *Cyathodes* clade (*sensu* Quinn *et al.* 2003).

The same studies (Quinn *et al.* 2003; Quinn *et al.* 2005) provide strong support for the monophyly of *Acrotriche* and indicate its closest relative to be *Lissanthe* R.Br. The remaining genera belonging to the *Cyathodes* clade, *Leptecophylla* Weiller, *Cyathodes* Labill.and the recently described *Agiortia* C.J. Quinn and *Acrothamnus* C.J. Quinn, are distributed in eastern Australia (especially Tasmania), New Zealand, New Guinea and the islands of the Pacific.

This paper presents a taxonomic update of the genus *Acrotriche* in Western Australia which includes the recognition of a new species, *A. lancifolia* Hislop, the transfer of *Trochocarpa parviflora* Stschegl. to *Acrotriche*, and discussion of the doubtful status of *A. depressa* R.Br. as a Western Australian species. Updated keys to the Western Australian members of *Acrotriche* and *Lissanthe* are also provided.

Notes on morphology

Several morphological features combine to make *Acrotriche* one of the more distinctive genera within the tribe *Styphelieae*. With the single exception of *A. dura*, a unique corolla hair distribution is definitive for the genus. Hairs are grouped in two distinct regions of the corolla – on the lobes as subapical tufts, and in the distal portion of the tube, either directly from an unmodified epidermis, or from 5 raised, cushion-like outgrowths in the throat. Also characteristic of the genus are the inconspicuous, usually greenish flowers arranged in multiflowered, relatively dense inflorescences which are either axillary or issue from bare nodes below the leaves. Three further significant floral attributes are: a style that is always included within the tube, usually fully exserted anthers, and straight (rather than distinctly twisted or crinkled) corolla hairs.

As noted above, the recent recognition of *Acrotriche dura* (Benth.)Quinn has significantly modified the long established morphological circumscription of the genus. This species is anomalous primarily in having a white corolla with hairs thinly and evenly distributed across the lobes and into the distal portion of the inner tube. Additionally it has anthers partially enclosed within the tube at anthesis rather than fully exserted and often held at right angle to the floral axis, which is the usual configuration for the genus. Although the distribution of the corolla hairs is certainly aberrant in *A. dura*, the species does share a modified indumentum character with the other Western Australian members of the genus. Between the rather sparsely distributed longer hairs of the corolla lobes are numerous papillae which presumably represent vestigial hairs. The same papillae are also present below the subapical corolla tufts of typical members of the genus.

Methods

Plant growth habit and proportions have been taken from collector's notes together with personal observations. Foliar measurements were taken from dried specimens. Leaf thickness was measured at the midrib, half way up the lamina. Observations of the leaf venation were made from mature leaves only. Across the Tribe *Styphelieae* it is common for the young leaves to show prominently raised venation on the abaxial surface which is often much less evident, if at all, at maturity. Similarly the first leaves produced at the beginning of a flush of vegetative growth should be ignored. The lowest of these are usually manifestly atypical and bract-like, undergoing morphological transition through successive nodes until they reach the form of the mature leaves.

Inflorescence length is measured from the insertion point of the lowest basal bract to the tip of the bud rudiment. Floral measurements were taken from re-hydrated flowers (at least six per specimen and from different inflorescences, assuming material is sufficient) in natural posture.

The distribution map was compiled using Diva version 5.2.0.2 and based on PERTH specimen data.

Keys, descriptions and lectotypification

Key to the Western Australian genera in the *Cyathodes* group (*sensu* Quinn *et al.* 2005)

1. Leaves slightly concave, flat or slightly convex, or if margins manifestly recurved then abaxial surface clearly visible. Inflorescence axillary or issuing from bare nodes below the leaves. Corolla predominantly greenish with hairs largely restricted to subapical tufts on the lobes* and in the distal portion of the tube (except *A. dura* which has white flowers with corolla hairs evenly distributed across the lobes and into the throat). Flowers never pedicellate above the bracteoles..**Acrotriche**

1. Leaves with revolute margins abutting the midvein and completely obscuring the abaxial surface. Inflorescence terminal, and sometimes also upper axillary. Corolla white, red or purple, hair distribution not as above. Flowers often pedicellate above the bracteoles (western species only)..**Lissanthe**

Key to the Western Australian species of *Lissanthe*

1. Inflorescence pendulous. Corolla purple throughout or occasionally greenish in basal half, lobes very short < 0.5 mm long, remaining closed over the tube at anthesis. Anthers cohering around the stigma. (Wellstead to Bremer Bay)..........**L. synandra**

1. Inflorescence erect. Corolla white or red, lobes > 1.8 mm long, spreading or recurved at anthesis. Anthers free from the stigma.

  2. Leaves obtuse. Corolla white. Flowers not or barely pedicellate above bracteoles. Ovary 1-locular. (Mostly coastal or subcoastal between Fitzgerald River National Park and Cape Arid National Park).....................**L. pleurandroides**

  2. Leaves acute with ± pungent mucros. Corolla white or red. Flowers clearly pedicellate above bracteoles. Ovary 3–7 locular.

    3. Corolla red, tube > 3 mm long. (Central southern districts between Ongerup and Israelite Bay and as far north as Kumarl, north of Salmon Gums)...............**L.rubicunda**

    3. Corolla white, tube < 3 mm long.

      4. Style hairy, well exserted from corolla tube. Ovary glabrous. (Northern sand-plains between Coomallo and the Mount Adams area) ....**L. powelliae**

      4. Style glabrous, stigma held at the throat of the corolla tube. Ovary hairy. (Central south west districts between the Bullfinch- Southern Cross area and Jaurdi station north of Boorabbin)... **L. scabra**

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* a very few hairs may be present below the subapical tuft.

Key to the Western Australian species of *Acrotriche*

1. Corolla white, hairs evenly distributed across the lobes and into the distal portion of the inner tube. (Borden–Wellstead–Ongerup area) .... **A. dura**

1. Corolla predominantly greenish, occasionally yellowish green or greenish suffused purple, hairs largely restricted to subapical tufts on the lobes* and in the distal portion of the inner tube

  2. Leaf apex long-mucronate, sharply pungent

    3. Leaves with recurved margins. Sepals *c.* 2 mm long. Corolla lobes 2 mm long or more (Stirling Range to the Ravensthorpe area and between Cape le Grand National Park and Israelite Bay).. **A. ramiflora**

    3. Leaves slightly concave, flat or slightly convex. Sepals to 1.7 mm long. Corolla lobes to 1.3 mm long

      4. Leaves ovate, occasionally narrowly ovate, 3–6 mm wide, most or at least some with cordate bases, veins 5–7(–9+), ± equally distinct, midrib to 0.1 mm wide. Corolla throat hairs issuing directly from unmodified epidermal cells. Endocarp with prominent longitudinal ribs (Coastal and subcoastal areas of the SE between Toolina Cove and the South Australian border).. **A. patula**

      4. Leaves narrowly ovate, 1.7–3.2 mm wide, base rounded but never cordate, veins 3–5 (usually 3) with the midrib prominent and usually produced into a distal abaxial keel, midrib 0.2–0.3 mm wide. Corolla throat hairs issuing from 5 raised, cushion-like outgrowths. Endocarp smooth (Central parts of the South West, between the Kondinin area in the west and the Bremer Range in the east, and between Great Eastern Highway in the north and the Lake King area) .... **A. lancifolia**

  2. Leaf apex usually obtuse or subacute, very occasionally acute but then with an innocuous callus tip.

    5. Subapical hair tuft arranged in a crescent-shaped formation. Ovary 7–10-locular. Drupe ± dry, endocarp with prominent longitudinal ribs (Stirling Range to Ravensthorpe area with an outlier W of Lake Grace)........... **A. parviflora**

    5. Subapical hair tuft a ± straight transverse band. Ovary 4–5-locular. Drupe with significant fleshy mesocarp, endocarp ± smooth (Mostly coastal between the central west coast near Leeman southwards along the west and south coasts to the South Australian border)................. **A. cordata**

* a very few hairs may be present below the subapical tuft.

Acrotriche patula R.Br. *Prod. Fl. Nov. Holl.* 547(1810).– *Styphelia patula* (R. Br.) Spreng., Syst. Veg. 1: 657(1824).

Type: Petrel Bay, Isle St. Francis, South Australia, 4 Feb. 1802, *R. Brown s.n.* (*lecto*: BM 000630019, here designated; *isolecto*: BM 000630018, scanned images seen).

Erect, divaricately branched *shrubs* usually to *c.* 60 cm high (rarely higher) and 60 cm across. Young *branchlets* medium to dark brown, with a moderate or dense indumentum of variably retrorse or patent hairs to 0.2 mm long; bark on older wood pale grey over brown, prominently fissured, retaining indumentum for several seasons but at length glabrescent. *Leaves* spirally arranged, widely spreading, from shallowly antrorse to shallowly retrorse, ovate or narrowly ovate, 8–16 mm long, 3–6 mm wide; apex a sharply pungent mucro to 1.1 mm long; base rounded or cordate; petiole well defined, pale yellowish green to pale brown, 0.7–1.3 mm long, hairy on the adaxial surface or throughout with an indumentum of short patent hairs; lamina 0.3–0.5 mm thick, slightly recurved along the longitudinal axis, usually slightly concave, less often flat or slightly convex; surfaces markedly discolorous, adaxial surface shiny, often with indistinct transverse wrinkles, glabrous or with a sparse short indumentum towards the base, venation not evident, abaxial surface paler, glabrous, with 5–7 or more ± equally distinct, closely spaced veins and significant secondary vein development, the midrib not or barely more prominent than the rest (to 0.1 mm wide), shallowly grooved between the veins; the margins ciliolate with very short, stiff cilia throughout or restricted to the distal half. *Inflorescence* axillary or issuing from bare nodes below the leaves, widely spreading or pendulous; the axis 3–5 mm long, with 5–10 flowers, terminating in a bud-like rudiment or a blunt point, the base ± obscured by imbricate sterile bracts; indumentum of dense straight or curved, mostly patent hairs to 0.2 mm long. *Flowers* green or yellow green, erect or spreading and sessile. *Fertile bracts* shallowly triangular to depressed-ovate, 0.7–0.9 mm long, 1–1.2 mm wide, glabrous on both surfaces except for a zone of short hairs close to the base on the abaxial surface and sometimes also along the median line, obtuse; venation obscure; margins ciliolate. *Bracteoles* ovate to almost circular, 1.1–1.5 mm long, 1–1.2 mm wide, keeled; abaxial surface sparsely hairy along the keel, sometimes only in the basal half, glabrous elsewhere; margins ciliolate. *Sepals* ovate, 1.5–1.7 mm long, 1.2–1.3 mm wide, obtuse, both surfaces glabrous, abaxial surface with inconspicuous venation, pale green or greenish cream, margins ciliolate. *Corolla tube* cylindrical, much longer than the sepals (by up to 3 mm), 2.2–4.2 mm long, 0.8–1.5 mm wide, the outer surface glabrous, the inner with 5 hair tufts in the throat issuing from unmodified epidermal cells (the hairs 0.5–0.8 mm long), glabrous below the tufts; *lobes* widely spreading 1–1.3 mm long, 0.7–0.9 mm wide at base, glabrous externally, the inner surface with prominent, subapical tufts (the hairs 0.6–0.9 mm long), and usually with a few hairs below the tufts often on the median line, the rest of the surface papillose; corolla lobes much shorter than the tube (ratio = 0.26–0.48:1). *Anthers* fully exserted at anthesis and usually held at right angles to the floral axis, 0.5–0.8 mm long; *filaments* terete, attached just below the anther apex, 0.2–0.4 mm long, adnate to tube just below the sinus. *Ovary* broadly ellipsoid or globose, 0.6–0.9 mm long, 0.6–0.8 mm wide, glabrous, 5–7-locular; *style* 0.5–0.8 mm long, tapering smoothly from the ovary apex, included within the corolla tube; *stigma* not or scarcely expanded; *nectary* annular 0.4–0.5 mm long, entire or with an undulate or slightly jagged rim, glabrous. *Fruit* depressed obovoid, 3.2–3.5 mm long, 3.4–4.2 mm wide, much longer than calyx, mesocarp fleshy, manifesting as a sharply raised reticulum of transverse and longitudinal ridges on dried specimens, endocarp with prominent longitudinal ribs, style persistent. (Figure 1 A–E)

Other specimens examined. WESTERN AUSTRALIA: Nullarbor Plain, *c.* 1 km N of Eucla, N side of Eyre Highway, 30 Aug. 1974, *A.C. Beauglehole* 49453 (NSW, PERTH); Hampton escarpment, near E boundary of Eucla town site, at Telecom fibre optics placement, 9 June 1995, *G.F. Craig* 3156 (PERTH); Hampton escarpment, track along base of scarp between Eyre Bird Sanctuary Rd and Madura, 10 June 1995, *G.F. Craig* 3171 (PERTH); 5.4 km E of Twilight Cove, 4 June 2000, *R. Davis* 9206 (PERTH); 4.1 km W of Toolinna, 4 May 2004, *R. Davis* 10672 (NSW, PERTH); Twilight Cove, Great Australian Bight, 11 July 1974, *A.S. George* 11869 (PERTH); 5.6 km ENE of Toolinna Rockhole, SW of Caiguna, 16 Oct. 1985, *G.J. Keighery & J.J. Alford* 1007 (CANB, PERTH); Norina Rockhole, Hampton Scarp, 7 Aug. 2004, *W.P. Muir* 336 (PERTH); Hampton escarpment, 115 miles W of Eucla, 5 Sep. 1963, *J.H. Willis s.n.* (PERTH); Near Point Dover, *c.* 380 km W of S.A.-W.A. border, edge of Great Australian Bight, 19 July 1967, *P.G. Wilson* 5908 (CANB, NSW, PERTH); Near Point Dover, half a mile from cliff edge, 20 July 1967, *P.G. Wilson* 5955 (CANB, PERTH). SOUTH AUSTRALIA: American River, Kangaroo Island, 18 Aug. 1958, *B.R. Paterson s.n.* (AD, HO, MEL, NSW, PERTH); 14 km E of S.A.-W.A. border, lookout point to Eucla, 2 Aug. 1979, *J.M. Powell* 1117 (K, L, NSW, PERTH).

Distribution and habitat. A. patula has a coastal or subcoastal distribution in the south-east of Western Australia between the Toolinna Cove area and the South Australian border. It is apparently restricted to areas of shallow soil over limestone and is a component of heathland communities. The species is more widely distributed in South Australia where according to Powell *et al.* (1986) it grows over ironstone as well as on coastal limestone. (Figure 2)

Conservation status. In Western Australia the species occurs in remote and sparsely populated areas where there appear to be no short term threats to its survival. Several known populations are conserved in Nuytsland Nature Reserve. Several collectors however do make note of the significant local impact of rabbit grazing on this species. A return to high rabbit numbers on the Nullarbor may jeopardize its long term future in this area.

Typification. The selection of BM 000630019 as lectotype follows the intention of J.M. Powell who annotated the specimen to that effect on 19 Oct. 1993 but did not publish the lectotypification before her retirement.

Notes. The fire response of this species does not appear to have been recorded but most western species including *A. lancifolia* are known to have lignotuberous, fire tolerant rootstocks. Although the absence in *A. patula*, of the cushion like outgrowths in the corolla throat, is generally a reliable character separating that species from *A. lancifolia*, one collection (*R. Davis* 9206) provides an interesting exception. In this case while the flowers do have clearly demarcated outgrowths in the throat, they are in the form of transverse ridges, rather than the elliptic shape characteristic of *A. lancifolia*. In all other respects the specimen is typical for the species.

Acrotriche lancifolia Hislop, *sp. nov.*

A patulae affinis sed folii venis paucioribus latioribus, tumoribus pulviformibus in fauce ornatis, et endocarpo laevi differt.

Typus: Parker Range *c.* 800 m due S of tank, Western Australia, 2 August 2003, *M. Hislop & F. Hort* MH 2983 (*holo*: PERTH 06756670; *iso*: CANB, NSW).

Erect, divaricately branched, lignotuberous *shrubs* to *c.* 150 cm high and 150 cm across. Young *branchlets* light to medium brown, glabrous or with a sparse, irregular indumentum of patent, straight hairs to 0.05 mm long, usually early glabrescent; bark on older wood pale grey over darker greyish brown, usually prominently fissured with the outer layer flaking. *Leaves* spirally arranged, rather variably orientated, from moderately antrorse to moderately retrorse on the same branchlet, narrowly ovate or less often narrowly elliptic, 6–13 mm long, 1.7–3.2 mm wide; apex a sharply pungent mucro to 1.6 mm long; base rounded; petiole well defined, pale yellowish green to pale brown, 1–1.6 mm long, with an irregular indumentum of short hairs on the adaxial surface; lamina 0.5–0.7 mm thick, straight or gently incurved along the longitudinal axis, usually slightly convex, less often flat or slightly concave; surfaces discolorous, adaxial surface either pruinose and matt, or shiny through surface abrasion, glabrous or with a very sparse, short indumentum towards the base, venation not evident, abaxial surface paler, glabrous, smooth, with 3 or less often 5 prominent, primary veins and limited secondary development from the 2 laterals, the midrib usually rather more prominent than the others (0.2–0.3 mm wide) and often produced into a distinct keel in the distal third; the margins usually glabrous or occasionally with very short and sparse distal cilia. *Inflorescence* axillary or issuing

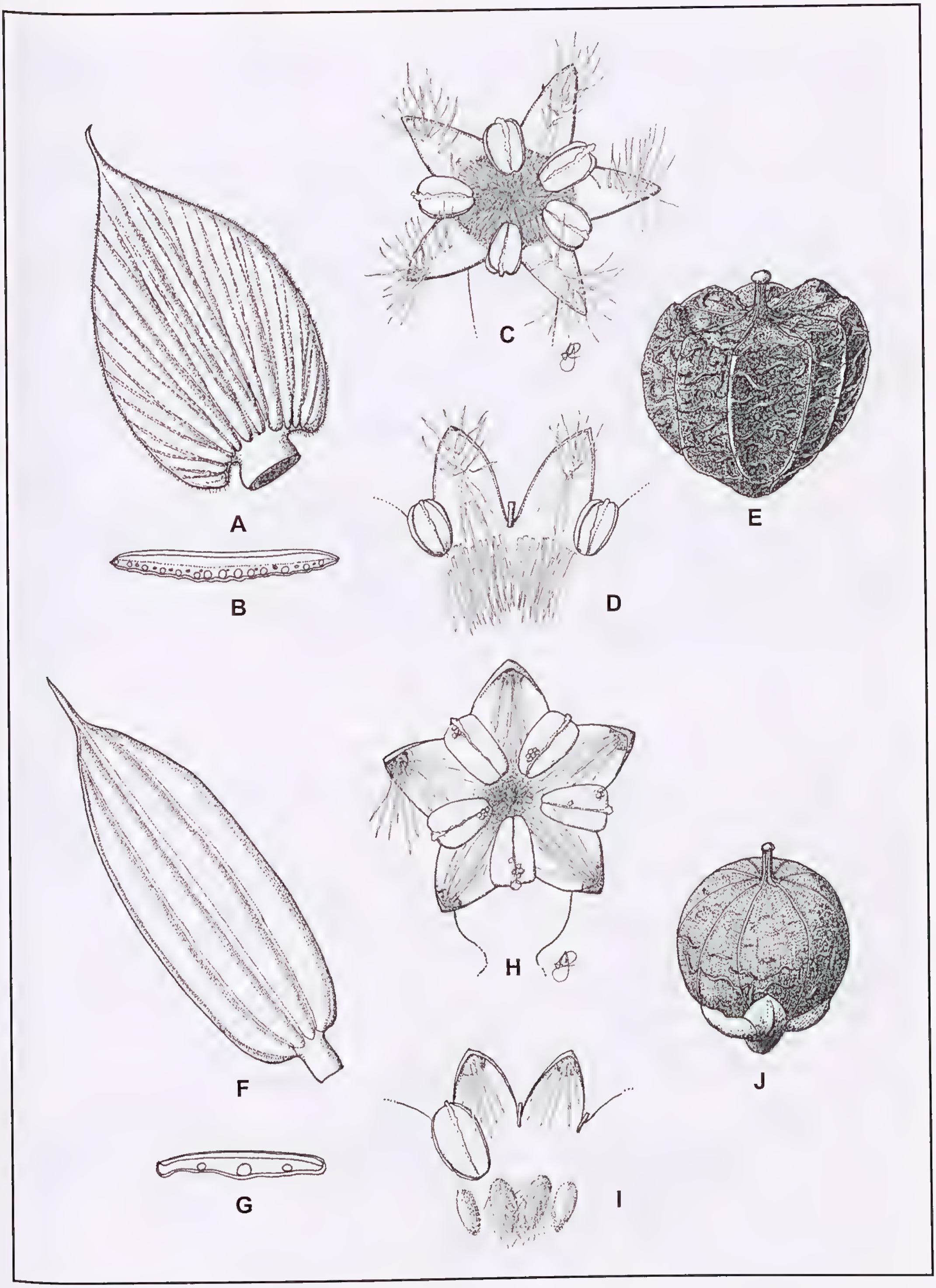

Figure 1. A–E. *Acrotriche patula*. A – leaf, abaxial surface, B – leaf, transverse section, C – corolla , D – upper portion of internal corolla tube, E – fruit; F–J. *Acrotriche lancifolia*. F – leaf, abaxial surface, G leaf, transverse section, H – corolla, I – upper portion of internal corolla tube, J – fruit. Drawn by Lorraine Cobb from *R. Davis* 10672 (A–D), *A.C. Beauglehole* 49453 (E), *M. Hislop* 3476 (F–I), *S.D. Hopper* 6872 (J).

from bare nodes below the leaves, mostly widely spreading, very occasionally pendulous; the axis 3–6(8) mm long, with 4–9(11) flowers, terminating in a bud-like rudiment or a blunt point, the base ± obscured by imbricate sterile bracts; indumentum of dense, curved and variably orientated hairs to 0.3 mm long. *Flowers* green or yellowish green but with the tube often suffused purple basally, erect or spreading and sessile. *Fertile bracts* shallowly triangular to depressed ovate, 0.9–1.1 mm long, 1–1.2 mm wide, glabrous or with a sparse short indumentum on abaxial surface, obtuse; venation inconspicuous. *Bracteoles* ovate, 1.1–1.5 mm long, 0.8–1.2 mm wide, keeled; glabrous apart from a few short hairs along the upper keel; minutely ciliolate along the upper and lower margins. *Sepals* ovate, 1.4–1.6 mm long, 1.1–1.4 mm wide, obtuse, both surfaces glabrous; abaxial surface with inconspicuous to moderately conspicuous venation, mostly pale greenish cream but often purple in an apical marginal band and between the veins in the distal half; margins very shortly and irregularly ciliolate. *Corolla tube* cylindrical, much longer than sepals (by up to 2.7 mm), 2.5–3.9 mm long, 1.1–1.5 mm wide, the outer surface glabrous, the inner with 5 hair tufts issuing from raised cushion like outgrowths (these hairs 0.3–0.5 mm long) in the throat, and a few hairs extending to the filament base, glabrous below the tufts; *lobes* widely spreading, 1–1.3 mm long, 0.7–0.9 mm wide at base, glabrous externally, the inner surface with prominent, subapical hair tufts (these hairs 0.4–0.7 mm long) and usually 1 or 2 scattered hairs below these tufts, the rest of the surface papillose; corolla lobes much shorter than the tube (ratio = 0.25–0.46:1). *Anthers* fully exserted at anthesis and usually held at right angles to the floral axis, 0.5–0.8 mm long; *filaments* terete, attached just below the anther apex, 0.3–0.5 mm long, adnate to tube just below the sinus. *Ovary* broadly ellipsoid or globose, 0.7–1 mm long, 0.7–0.9 mm wide, glabrous, 5–6(7) locular; *style* 0.7–1.1 mm long, tapering smoothly from ovary apex, included within corolla tube; *stigma* not expanded; *nectary* annular 0.4–0.6 mm long, entire or with slightly jagged rim, glabrous. *Fruit* globose, depressed-globose or depressed-obovoid, 2.6–3.1 mm long, 2.8–3.2 mm wide, much longer than calyx; mesocarp thin, manifesting as a shallow reticulum of transverse and longitudinal ridges on dried specimens; endocarp smooth; style persistent. (Figure 1 F–J)

Other specimens examined. WESTERN AUSTRALIA: Bremer Range, 8.7 km SE of Mount Gordon, 6.1 km ENE of Bremer Range track along track to Lake Medcalf, *c.* 20 km NE of Ninety Mile Tank, 21 Sep. 2002, *B. Archer* 2204 (CANB, MEL, PERTH); Hatter Hill Rd, 9.5 km S of intersection of Broombrush Rd and Digger Rocks – Hatter Hill Rds, *c.* 50-100 m NW of trig, 17 Oct. 1997, *E.A. Brown* 97/315, *P.G. Wilson & N. Lam* (NSW, NY, PERTH, UNSW); Dragon Rocks Nature Reserve no. 36128, north western section, 27 Aug. 1991, *A.M. Coates* 2618 (PERTH); Bremer Range, *c.* 0.9 km N of Hill 436, on E side of road, 20 m in, on sheet laterite, 15 Sep. 1994, *N. Gibson & M. Lyons* 1782 (PERTH); Frog Rock Nature Reserve, SW of Southern Cross, low breakaway N of main granite exposure, 1 Aug. 2003, *M. Hislop & F. Hort* MH 2970 (CANB, NSW, PERTH); UCL on N side of Brennan Rd, 6.8 km W of Panizza Rd, SW of Marvel Loch, 24 July 2005, *M. Hislop* 3476 (CANB, PERTH); 5.6 km NE of Hatters Hill on Lake Hope track, *c.* 45 km NE of Lake King, 28 Sep. 1988, *S.D. Hopper* 6872 (PERTH); S side of reserve track, 1.8 km E of Greay Rd (at base of breakaway), track leaves road 2.8 km S of Bendering Reserve Rd, North Karlgarin Nature Reserve, *c.* 24 km NE of Kondinin, 24 Sep. 1997, *G.J. Keighery & N. Gibson* 5765 (PERTH); 50 m SSE of Cockatoo Tank, 13.1 km S of Marvel Loch, 19 Oct. 1990, *F.H. & M.P. Mollemans* 3728 (PERTH); 3.75 km S of Duck Rock West Rd, 4 km SSW of the junction of Duck Rock West and Carlson Rds and 35 km ESE of Hyden, 13 Sep. 1991, *F.H. & M.P. Mollemans* 4264 (PERTH); 1 mile S of Hatter Hill, 4 Sep.1970, *K.R.Newbey* 3300 (CANB, NSW, PERTH); 10 km SW of Lake Cronin, *c.* 75 km E of Hyden, 3 Oct. 1979, *K.R. Newbey* 6178 (PERTH); 16 km SSE of Marvel Loch, 23 July 1981, *K.R. Newbey* 8334 (PERTH); NW margin of Lake Ace, 2 May 1985, *K. Newbey* 10926 (PERTH).

Distribution and habitat. Acrotriche lancifolia is distributed from the eastern wheatbelt in the Kondinin area, eastwards at least as far as the Bremer Range, well beyond the agricultural districts, and from close to the Great Eastern Highway in the north to the Lake King area. It generally occurs on and around decomposing granitic or lateritic breakaways in shallow, rocky, loam or sandy loam soils and in open mallee woodland or shrubland communities where it may be locally dominant. (Figure 2)

Phenology. The main flowering period is between July and September, probably commencing earlier if soil moisture levels are unseasonably favourable. Mature fruit has been collected as early as September.

Etymology. The species epithet derives from the Latin *lancea* – a light spear or lance, and refers to the leaf shape. It is also intended to highlight a foliar difference between the new species and *A. patula*, in that the latter generally has broader, more obviously ovate rather than lanceolate leaves.

Conservation status. Although *A. lancifolia* is apparently rather specific as to habitat requirements, it has quite a wide distribution which extends into largely uncleared country to the east of the agricultural regions of the state. Populations are also conserved in several nature reserves across the eastern wheatbelt. It is therefore not recommended for inclusion on the Department Environment and Conservation's Priority Flora List.

Notes. Although quite widely distributed and locally common, the first collection of the new species was made as recently as 1970 (*K. Newbey* 3300). That specimen was treated by Jackes & Powell (1980) as a new record of *Acrotriche patula* from Western Australia. They did recognise however that the specimen was not typical of *A. patula*, describing it as a 'variant' of that species which had 'larger' and 'darker green' flowers. Although there is a tendency for larger flowers in *A. lancifolia*, these floral characters do not provide a useful basis for distinguishing the two species. It is somewhat surprising

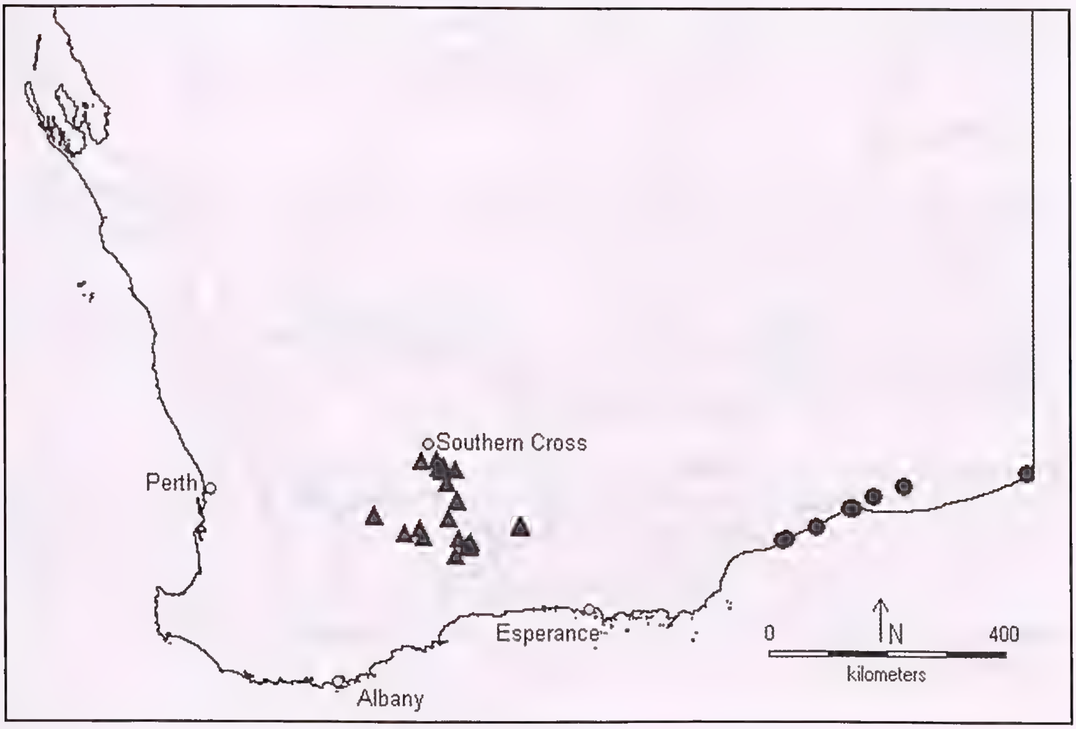

Figure 2. Distribution of *Acrotriche patula* ● and *A. lancifolia* ▲.

though that the authors did not seize upon two of the primary differences between the species – those of leaf anatomy and the presence/absence of cushion like outgrowths in the corolla throat. There is no doubt that the authors were aware of the significance of these characters as they were both employed elsewhere in their paper.

Coincidentally, Jackes & Powell were apparently unaware that by 1980 at least 4 collections of *A. patula sens. str.* had been made along the SE coast of Western Australia, the first of these by J.H. Willis in 1963.

Affinities. As noted above the new species is similar to and has for many years been confused with *A. patula*. Apart from the characters used in the key (and rather unusually in the tribe *Styphelieae* generally), a reliable difference in the branchlet indumentum also serves to separate the two. Whereas *A. lancifolia* has young branchlets either glabrous or with very short, sparse patent hairs and soon glabrescent, *A. patula* consistently has a longer, denser, more persistent indumentum of usually ± retrorse hairs.

There is a further, interesting distinction regarding the general aspect of the two species in the field. Many collectors note the bluish-green appearance of *A. lancifolia* which on close examination is seen to be caused by a pruinose coating on the leaves. This is usually still quite observable on dried specimens, although occasionally appearing wholly absent. There are no such field observations of pruinosity in the case of *A. patula* and neither was any trace of it seen on the specimens examined during this study.

The two species are geographically disjunct within Western Australia, with *A. lancifolia* having an inland distribution in the central south west of the state and *A. patula* occurring in the coastal south-east.

Acrotriche parviflora (Stschegl.) Hislop, *comb. nov.*

Decaspora parviflora Stschegl., *Bull.Soc.Imp.Naturalistes Moscou* 32 (1):10 (1859). *Trochocarpa parviflora* (Stschegl.) Benth., *Fl.Austral.* 4:167 (1868). *Type*: 'Nova Hollandia. *Drummond* coll. 4, no. 157' (*iso*: PERTH 00998699).

Acrotriche plurilocularis Jackes, *Telopea* 1:422-425 (1980). *Type*: 'Western Australia: Pallinup River, 4 km from the coast, rocky loam, 18-36 ins, *K.R. Newbey* 2998, 23 Nov. 1969' (*holo*: PERTH 01136224; *iso*: AD, BRI, CANB, CHR, K, L, MEL, NSW).

Notes. This species was first described under *Decaspora* R.Br. by Stschegleew (1859) but was later transferred to *Trochocarpa* R.Br. by Bentham (1869). Brown (1810) distinguished between these two genera, which he acknowledged were closely related, mainly by a difference in corolla shape and habit - *Trochocarpa laurina* (the genus was then monotypic) being a tree, and members of *Decaspora* low shrubs. Most later authors however, took the view that the two were congeneric and this was formalized by Bentham (1869) when he sank those species remaining in *Decaspora* into an expanded *Trochocarpa*.

Although there may still be a case for the recognition of two genera, it is clear that *Trochocarpa parviflora* is not closely related to either of these. The green flower colour, pattern of the corolla hair distribution and strictly axillary inflorescence are all typical of the genus *Acrotriche*. On the other hand no species of *Trochocarpa* have an Acrotriche-like corolla hair distribution and all members of that genus have a terminal or terminal and upper axillary inflorescence.

The type of *Decaspora parviflora* has mature fruits present but only very immature flower buds and this must surely be the reason that both Stschegleew and Bentham, neither of whom apparently saw any other material, were misled as to the species' true affinities. Two fundamental morphological attributes of *Trochocarpa* are the numerous ovary locules (usually *c.* 10), and a drupe that spontaneously dissociates into loose pyrenes within the mesocarp at maturity. *A. parviflora* with 7-10 locules is similar to *Trochocarpa* in this respect, but several other species of *Acrotriche* also often have >5 locules and *A. aggregata*, as Bentham himself recognised, may also have as many as 10. In relation to their fruiting characteristics however, any similarities between *T. parviflora* and the members of *Trochocarpa sens. str.* are superficial only. Although the deeply ribbed fruiting endocarp of *T. parviflora* will break up under moderate pressure there is no doubt that, in the normal course of events, it is intact at the time of dispersal. The pericarp and mesocarp in this species are also very insignificant and do not appear to play an obvious role in the fruit's dispersal. This is not the case with the fruit of *Trochocarpa sens. str.* where the free pyrenes are held within a pulpy mesocarp, which is enclosed inside a persistent, usually colourful pericarp - the whole mature drupe being apparently well adapted to dispersal by fructivorous vertebrates.

The species was described a second time, as *Acrotriche plurilocularis*, by Jackes in Jackes & Powell (1980). However this was apparently done without consideration of the true identity of the disjunct *Trochocarpa parviflora*.

A curious feature of Jackes' description is that no mention is made of the distinctive, crescent shaped, corolla lobe hair tuft. The accompanying illustration, in fact shows a ± transverse tuft which is the common configuration for the genus. This character is the easiest means by which to separate flowering specimens of the species from *A. cordata* which is often very similar in its vegetative morphology.

Other specimens examined. WESTERN AUSTRALIA: Quaalup, Gairdner River, 16 Oct. 1928, *C.A. Gardner* 2230 (PERTH); Stirling Range National Park, Mt James track close to creek crossing *c.* 2 km W of Bluff Knoll access road, 31 Aug. 2005, *M. Hislop* 3490 (CANB, NSW, PERTH); 3 km N of Cheyne Beach, near rubbish tip, 27 Feb. 1983, *G.J. Keighery* 5952 (PERTH); 1 km west of Kamballup on Woogenilup Rd, 15 Sep. 1985, *G. J. Keighery & J.J. Alford* 413 (PERTH); Base of breakaway on gridline in SE of North Tarin Rock Nature Reserve, 24 Sep. 1997, *G.J. Keighery & N. Gibson* 7099 (PERTH); 25 km W of Bremer Bay, 14 Sep. 1969, *K. Newbey* 2878 (AD, BRI, CANB, CBG, CHR, K, L, MEL, NSW, PERTH, RSA); 2 km south of Kundip, 11 Oct. 1969, *K.R. Newbey* 2923 (AD, CANB, NSW, PERTH); Millars Point Rd, slope above Beaufort Inlet, 17 Nov. 1992, *C.J. Robinson* 1016 (PERTH); 2.4 km W of Chillinup Pool on Chillinup Rd, 21 Oct. 1992, *C.J. Robinson* 1180 (PERTH); Bushland remnant NE corner of Plantagenet Location 3259, E of Chester Pass Rd, *c.* 2.5 km NNE of Kamballup, 5 Nov. 2002, *E.M. Sandiford* EMS 650 (ALB, PERTH); E of Holmes Rd, Lake Chillinup Nature Reserve, South Stirlings, 14 Nov. 2002, *E.M. Sandiford* EMS 680 (ALB, PERTH).

Distribution. Acrotriche parviflora is distributed across subcoastal or occasionally more inland districts between the Stirling Ranges in the west to around Kundip, north of Hopetoun in the east, with a disjunct population near Tarin Rock west of Lake Grace.

Conservation status. As *Trochocarpa parviflora* the species has been treated as a Priority Three taxon (Conservation Codes for Western Australian Flora). However, its conservation status is now determined as Priority Four in the light of the combined distribution of specimens previously housed at PERTH under *Acrotriche plurilocularis*. At least 4 populations are conserved in nature reserves or National Parks.

Acrotriche depressa R.Br., *Prod. Fl. Nov. Holl.* 548(1810).– *Styphelia depressa* (R.Br.) Spreng., *Syst. Veg.* 1(1824). Type citation: "(M.) v.v. absque flor. fruc. vix matur." *Type:* Kangaroo Island [South Australia], 5 April 1802, *R. Brown s.n.* (*holo:* BM).

Notes. Since the nineteenth century this species has been considered native to Western Australia as well as South Australia. Bentham (1869), Ewart (1930), Black (1952) and Paterson (1960) included Western Australia in their distribution statements for the species (although Paterson noted that she had personally not seen material from that state). It was also treated by Blackall and Grieve (1981).

It appears that all were influenced by a single collection made by William Baxter in the 1820's with the notation 'Sand ridges, Bald Head' - this presumably being the Bald Head at the tip of the Flinders Peninsula SE of Albany. Although the Albany area is now well known botanically, no subsequent collections of *A. depressa* have been made from here or anywhere else in Western Australia in the intervening 180 years. Baxter collected extensively near Albany and elsewhere in south coastal districts of Western Australia but is also known to have collected at Kangaroo Island off the coast of South Australia (Kraehenbuehl 1986).

A close examination of the Baxter collection suggests that the knowledge of his subsequent visit to Kangaroo Island may in fact be relevant information. Although the fragment at PERTH is very small, the detail of its foliar morphology exactly matches that of the Kangaroo Island variant of the species, which as noted by Powell *et al.* (1986), is characterised by 'smaller, shorter, almost cordate based leaves'. Given the fact of this distinctive foliar morphology and the complete absence of subsequent Western Australian collections, it now seems reasonable to believe that the Baxter specimen was really collected at Kangaroo Island and that the annotation 'Bald Head' is erroneous. The other possibility, that a very disjunct western population of the species, indistinguishable from the Kangaroo Island variant, was extant in the early nineteenth century but now extinct, seems very much less likely.

Specimens examined. SOUTH AUSTRALIA: Strathalbyn, 26 Aug. 1958, *B.R. Paterson s.n.* (AD, NSW, PERTH); American River, Kangaroo Island, 18 Aug. 1958, *B.R. Paterson s.n.*(AD, BRI, MEL, NSW, PERTH); Sand ridges, Bald Head (now believed to have been collected on Kangaroo Island), *W. Baxter s.n.* (PERTH).

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Blackallia, *Serichonus* and *Papistylus*: three closely related genera of Rhamnaceae (Pomaderreae) from south-western Australia

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Jürgen Kellermann [1,2,3], Barbara L. Rye [4] & Kevin R. Thiele [4]

[1] National Herbarium of Victoria, Royal Botanic Gardens Melbourne, Birdwood Avenue, South Yarra, Victoria 3141
[2] School of Botany, The University of Melbourne, Victoria 3010
[3] Current address: State Herbarium of South Australia, Plant Biodiversity Centre,
PO Box 2732, Kent Town, South Australia 5071
[4] Western Australan Herbarium, Department of Environment and Conservation,
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983

Abstract

Kellermann, J., Rye, B.L. & Thiele, K.R. *Blackallia*, *Serichonus* and *Papistylus*: three closely related genera of Rhamnaceae (Pomaderreae) from south-western Australia. *Nuytsia* 16(2): 299–316 (2007). Recent molecular and morphological studies of Pomaderreae indicate that a number of species that have traditionally been of uncertain affinity require new genera. *Blackallia* C.A. Gardner is lectotypified and restricted to one species, *B. nudiflora* (F. Muell.) Rye & Kellermann, for which a new combination is made. Two new genera are described, *Serichonus* K.R. Thiele comprising the single species *S. gracilipes* (Diels) K.R. Thiele, and *Papistylus* Kellermann, Rye & K.R. Thiele with two species, *P. grandiflorus* (C.A. Gardner) Kellermann, Rye & K.R. Thiele and the new species *P. intropubens* Rye. All three genera are restricted to the South West Botanical Province of Western Australia. They are closely related but can be readily distinguished from one another by some significant morphological differences, especially in their inflorescences. A revised key to the genera of Pomaderreae is presented and lectotypes are chosen for *B. nudiflora* and *S. gracilipes*.

Introduction

The tribe Pomaderreae (Rhamnaceae) is restricted to Australia and New Zealand. It currently comprises approximately 220 species in eight genera: *Blackallia* C.A. Gardner (2 species), *Cryptandra* Sm. (*c.* 55), *Polianthion* K.R. Thiele (4), *Pomaderris* Labill. (*c.* 70), *Siegfriedia* C.A. Gardner (1), *Spyridium* Fenzl (*c.* 45), *Stenanthemum* Reissek (*c.* 30) and *Trymalium* Fenzl (13). All of these genera are represented in Western Australia, with the two smallest genera endemic there and three others (*Polianthion*, *Stenanthemum* and *Trymalium*) showing their maximum development in the State. Keys to the genera of Rhamnaceae in Western Australia are given in the accompanying paper by Rye (2007) for central and southern Western Australia and in Rye (1997) for the Kimberley region.

During revision of the Western Australian taxa (e.g. Rye 1995a,b, 1996a,b, 2000, 2001), molecular systematic work on the generic limits of Pomaderreae (Kellermann *et al.* 2005, Kellermann 2007, Kellermann & Udovicic 2007), and on-going work on the "Flora of Australia" treatment of the family (Thiele *et al.*, in prep.), it has become clear that several species do not readily fit into any of the currently named genera. In a previous paper, Kellermann *et al.* (2006) established *Polianthion* for four unusual species that were misplaced in *Cryptandra*, *Pomaderris*, and *Trymalium*. In this paper we clarify the status of *Blackallia* and establish two new genera, the monotypic *Serichonus* and *Papistylus* with two species. A key to all genera of the tribe Pomaderreae is presented, reflecting the recent taxonomic changes made in Rye (1995b, 2007), Thiele & West (2004), Kellermann *et al.* (2006) and this paper. The different types of discs, fruitlets and stipules found in the tribe and referred to in the text are explained and illustrated in Thiele (2007).

Key to the genera of Pomaderreae

1 Leaves opposite; flowers in pendent, terminal heads surrounded by an involucre of large coloured bracts .... **Siegfriedia**

1: Leaves alternate; flowers not as above

  2 Flowers without a distinct floral tube [except *Trymalium urceolare* (F. Muell.) Diels]; sepals wide-spreading at anthesis

    3 Fruitlets indehiscent; stamens incurved, enclosed at first by the hooded petals ..... **Trymalium**

    3: Fruitlets dehiscent (usually by a window on the inner face); stamens ± straight (rarely incurved), not hooded by the petals .... **Pomaderris**

  2: Flowers with a distinct (though sometimes very short) tube; if apparently without a tube then sepals incurved to erect at anthesis

    4 Floral disc hairy (rarely glabrous); stipules basally fused around the outside of the petiole and often enclosing it, not connate between the petiole and axis .... **Cryptandra**

    4: Floral disc glabrous; stipules various, not fused around the outside of the petiole, but often connate between the petiole and axis

      5 Flowers in densely contracted cymose heads subtended by broad, persistent, prominent bracts, often surrounded by whitish or green floral leaves

        6 Disc prominent, at the summit or the base of the floral tube

          7 Disc at the summit of the hyanthium tube, indented adjacent to the stamens; fruitlets indehiscent, papery, enclosing the seed when shed .... **Spyridium**

          7: Disc at the base of the floral tube, forming a prominent ring; fruitlets dehiscent, crustaceous, releasing the seed at maturity .... **Papistylus**

        6: Disc lining the floral tube and confluent with the staminal filaments (sometimes obscure) .... **Stenanthemum**

      5: Flowers not in dense heads; bracts small, persistent or scarious and deciduous; floral leaves absent

        8 Flowers long-pedicellate, glabrous; ovary and fruit largely to fully superior ...... **Blackallia**

        8: Flowers sessile to long-pedicellate, pubescent or pilose; ovary and fruit *c.* half to fully inferior

          9 Disc at the summit of the floral tube; fruitlets indehiscent, papery, enclosing the seed when shed .... **Spyridium**

          9: Disc forming a ring around the ovary at the base of the floral tube; fruitlets dehiscent, crustaceous, releasing the seed at maturity

            10 Flowers and leaves densely stellate-hairy; ovary 2-locular .... **Polianthion**

            10: Flowers and leaves simple-pubescent or pilose (stellate hairs, if present, obscured by the simple ones); ovary 3-locular .... **Serichonus**

Taxonomy

Blackallia C.A. Gardner, *J. Roy. Soc. Western Australia* 27: 183 (1942), emend. Kellermann, Rye & K.R. Thiele. *Lectotype* (here designated): *Blackallia biloba* C.A. Gardner = *Blackallia nudiflora* (F. Muell.) Rye & Kellermann.

Excluded species: Blackallia connata (C.A. Gardner) C.A. Gardner, *J. Roy. Soc. Western Australia* 27: 184 (1942). ≡ *Cryptandra connata* C.A. Gardner, *J. Roy. Soc. Western Australia* 14: 80, plate 3H–L (1928). *Type:* Sandstone, Western Australia, 19 July 1927, *C.A. Gardner s.n.* (*lecto:* PERTH 01599259, *fide* Rye, *Nuytsia* 16: 355 (2007); *isolecto:* PERTH 01599240).

Small evergreen *shrubs*, usually spinescent, glabrescent with simple and stellate hairs on the young leaves. *Stipules* connate at base between the petiole and stem, ± persistent. *Leaves* alternate-fasciculate, petiolate, discolorous, entire, conduplicate when young, margins flat. *Inflorescence* comprising several flowers in densely contracted cymes with cymose bracts. *Flowers* bisexual, 5-partite, white or cream to pale pink when young, long-pedicellate. *Hypanthium* long-tubular, usually slightly widened at base. *Sepals* ± erect, persistent in fruit. *Petals* erect, cucullate, shortly clawed, smooth; claw not adnate to base of stamen filament. *Stamens* enclosed in and shorter than or subequal to the petals, erect to incurved. *Disc* forming a narrow, undulate ring around the ovary base, free, glabrous, becoming circular in fruit. *Gynoecium* of 3 carpels; ovary superior or largely so; style entire, glabrous, smooth, stigma slightly 3-lobed. *Fruit* a schizocarpic capsule, superior or largely so, obovoid; fruitlets crustaceous, splitting longitudinally along their inner surface and over the summit to release the seed. *Seeds* arillate; body uniformly coloured above a darkened base; aril moderately large, translucent, 3-lobed.

Etymology. The genus is named after the Western Australian doctor and botanist W.E. Blackall (1876–1941).

Distribution. A monotypic genus endemic to the south-west of Western Australia.

Notes. Gardner (1942) erected his new genus *Blackallia* to accommodate two species: *Blackallia connata* (C.A. Gardner) C.A.Gardner and *Blackallia biloba* C.A. Gardner. The latter is a synonym of *Cryptandra nudiflora* as Mueller had already described the species in 1862.

Gardner did not nominate a type species for the genus, but possibly gave prominence to *B. connata* as he listed it first, followed by a full description of his new species *B. biloba.* In a draft version of his manuscript, housed at PERTH, Gardner treated *Blackallia* as a monotypic genus comprising *B. connata* only. However, *Blackallia connata* clearly belongs in *Cryptandra* on the basis of morphological (Rye 2007) and molecular data (Kellermann *et al.* 2005). Hence, *B. biloba* is selected here as the lectotype of the genus and the new combination *Blackallia nudiflora* is made below. *Blackallia connata* is removed from the genus and accepted as *Cryptandra connata*; the closely related *C. imbricata* Rye is described in Rye (2007), who also discusses the affinities of these two species within *Cryptandra*.

Blackallia is similar to *Serichonus* and *Papistylus* in its conduplicate young leaves, long floral tube and glabrous disc. It differs from the other two genera in its spinescent habit, fasciculate leaves, smooth glabrous style and largely to fully superior glabrous ovary and fruit. *Blackallia* and *Serichonus* both differ from *Papistylus* in their long-pedicellate flowers, but *Blackallia* differs from *Serichonus* in the densely contracted inflorescence and smaller leaves which are soon glabrous. Flowers in *Serichonus* are arranged in open, loose cymes.

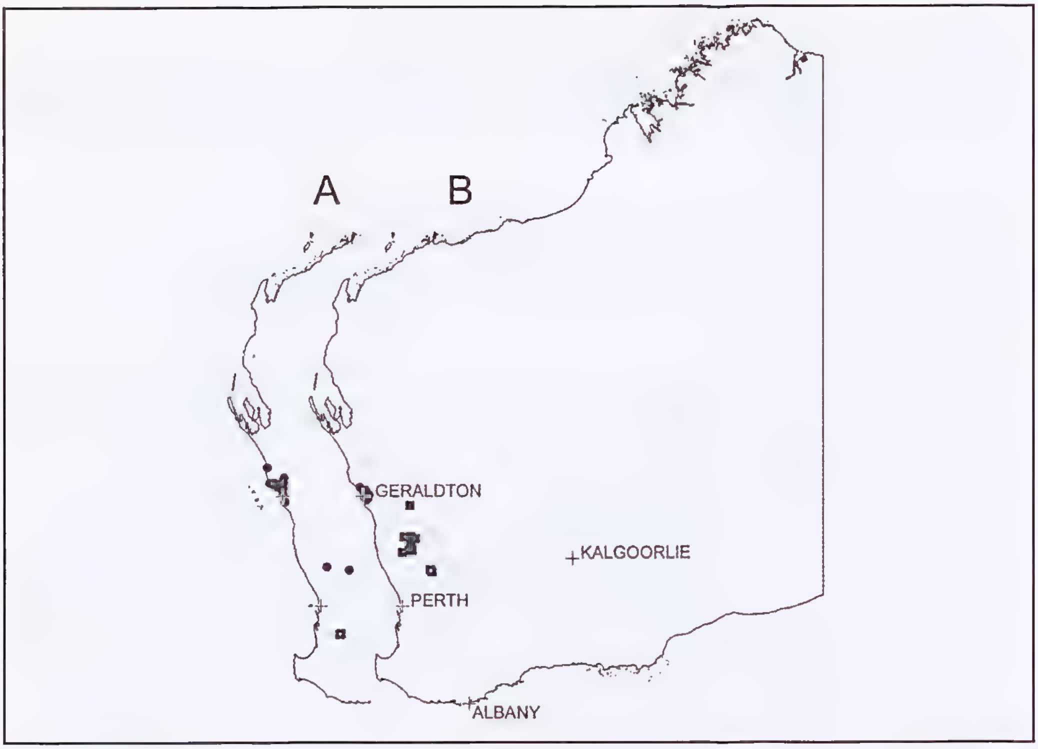


Figure 1. Distribution maps. A – *Blackallia nudiflora* (●), *Papistylus intropubens* (■); B – *Papistylus grandiflorus* (■), *Serichonus gracilipes* (●).

Blackallia nudiflora (F. Muell.) Rye & Kellermann, *comb. nov.*

Cryptandra nudiflora F. Muell, *Fragm.* 3: 64 (1862). *Type citation:* "In locis tam saxosis tam arenosis ad portum Gregory et flumen Murchison. Oldfield." *Type:* Port Gregory, Western Australia, *A.F. Oldfield s.n.* (*lecto:* MEL 1618388, here designated; *isolecto:* MEL 1618389; K, top left specimen on sheet with loan stamp 21/1310/95 64/76). *Other material:* Murchison River, Western Australia, *A.F. Oldfield s.n.* (*residual syn:* MEL 1618193; K, bottom specimens on sheet with loan stamp 21/1310/95 64/76).

Blackallia biloba C.A. Gardner, *J. Roy. Soc. Western Australia* 27: 184 (1942). *Type:* between Northampton and Lynton, Western Australia, September 1940, *W.E. Blackall* 4517 (*holo:* PERTH 01751468).

Illustrations. W.E. Blackall & B.J. Grieve, *How Know W. Austral. Wildfl.*, 1st edn, 2: 338 (1956) [as *Blackallia biloba*]; B.J. Grieve, *How Know W. Austral. Wildfl.*, 2nd edn, 2: 599 (1998) [as *Cryptandra nudiflora*].

Shrubs 0.3–1 m high, often with spinescent branchlets 5–35 mm long, the leaves alternate-fasciculate (sometimes most leaves fallen but a tight cluster of nodes still apparent); long branches often arching to the ground. *Young stems* reddish with minute appressed simple hairs at first but soon becoming glabrous. *Stipules* scarious, narrowly triangular to triangular, 0.8–1.2 mm long, connate for up to half their length between the petiole and the stem, glabrous or with simple hairs along the midvein and/or on the margins, often denticulate; apex acute. *Petiole* 0.2–1.5 mm long, glabrous. *Leaf blades* conduplicate at first, entire, narrowly obovate to narrow-oblanceolate, 3–13 mm long, 0.9–5 mm wide; base narrowly cuneate, apex obtuse to emarginate with a slightly recurved tip; lower surface densely silky hairy when young with long simple antrorse hairs overlying few stellate hairs, soon glabrescent with simple appressed hairs along midvein and sometimes also a few elsewhere; upper surface glabrous. *Inflorescence* of long-pedicellate flowers arranged in very densely clustered 3–5-flowered cymes in the axils of the fasciculate leaves (i.e., the flowers appearing to be in lateral umbels on short shoots); bracts at base of pedicels persistent, small, inconspicuous, triangular, *c.* 0.5 mm long, acute, quite glabrous. *Flowers* white at first, then pale pink with 10 darker longitudinal stripes, becoming deep pink in fruit; pedicel 1.4–4 mm long. *Floral tube* 1.5–2.5 mm long (enlarging to *c.* 3 mm in fruit), 1.8–2.5 mm in diameter, glabrous throughout, almost entirely free, distinctly tubular, broadest and indented at the usually bulging base. *Sepals* erect or slightly spreading, 1.2–2.3 mm long, glabrous. *Petals* 0.8–1.2 mm long, distinctly clawed. *Stamens* 0.7–1 mm long, the anther 0.3–0.4 mm long. *Disc* smooth. *Ovary* summit smooth and glabrous. *Style* 1.7–2.6 mm long, persistent in fruit. *Fruit* fully or almost fully superior, obovoid, 2.8–3.2 mm long. *Seeds* compressed, elliptic-obovate in outline, *c.* 1.8–2 mm long, 1–1.3 mm wide, somewhat darkened at base, uniformly orange-brown above, shiny; aril *c.* 0.4 mm long, orange-brown-translucent, compressed, very shortly 3-lobed. (Figure 2A–D)

Other specimens examined. WESTERN AUSTRALIA [precise localities withheld]: S of Northampton, 16 Aug. 1964, *A.M. Ashby* 1000 (collected by *Mrs Cramer*) (AD); N of Port Gregory road junction with Kalbarri coastal road, 9 Sep. 1994, *B. & B. Backhouse* NC 52 (PERTH); between Northampton and Lynton, Sep. 1940, *W.E. Blackall* 4517 (PERTH); N bank of Chapman River, 5 Aug. 2002, *J. Brooker* 427 (PERTH); Yerina Spring road, 9 Aug. 1994, *A.P. Brown* 1119 (PERTH) & 10 Sep. 2001, *J. Kellermann* 228 (MEL); E of Ogilvie, 28 July 1968, *A.C. Burns* 20 (PERTH); Bishops Gully Rd, 8 July 1997, *R. Davis* 3623 (PERTH); Yerina Spring, *c.* 30 km NW of Northampton, 15 Aug. 2001, *R. Davis* 9908 (PERTH); 18 km N of Northampton, 2 Sep. 1985, *H. Demarz* 10719 (PERTH); Hutt River, Sep. 1959, *C.A. Gardner s.n.* (PERTH); W side of North West Coastal Highway, N of Northampton, 3 Oct. 1998, *N. Gibson* 4119 (PERTH), 12 Sep. 2001, *J. Kellermann* 256 (MEL) & 7 Aug. 1994, *S.J. Patrick* 1958 (PERTH); O'Kagu [Oakajee], *s.dat.*, *A.F. Oldfield s.n.* (MEL); Mugiegaby [Munga Gabby], *s.dat.*, *A.F. Oldfield s.n.* (MEL); Ogilvie West Rd, W of North West Coastal Highway, 7 Aug. 1994, *S.J. Patrick* 1960 (PERTH); Port Gregory Road, 7 Aug. 1994, *S.J. Patrick* 1968 (PERTH); Rob Rd, SE of Port Gregory, 8 Aug. 1994, *S.J. Patrick* 1969 (PERTH); Yallabatharra Rd, SE of Port Gregory, 8 Aug. 1994, *S.J. Patrick* 1972 (PERTH); Ogilvie East Rd on E side of Old North West Coastal Highway, 13 Aug. 1996, *S.J. Patrick* 2713 (PERTH); W side of Chilimony Rd, 13 Aug. 1996, *S.J. Patrick* 2711 *& A. Brown* (PERTH); E side of Old North West Coastal Highway, 13 Aug. 1996, *S.J. Patrick* 2715 *& A. Brown* (PERTH); *c.* 350 miles [565 km] from Perth on Carnarvon road, 20 July 1967, *E.B.J. Smith s.n.* (PERTH).

Specimens examined of southern variant. WESTERN AUSTRALIA: S of Moora, near Koojan, 9 Sep. 1969, *C. Chapman s.n.* (PERTH); S of Koojan, 17 Aug. 1978, *C. Chapman s.n.* (PERTH).

Distribution. Endemic to the South West Botanical Province of Western Australia, principally from near the coast in the Hutt River area inland to east of Ogilvie, and south to Chapman River, with a disjunction of over 250 km to a much smaller area of occurrence south of Moora. (Figure 1A)

Habitat. Occurs in low shrublands, on clay or sandy clay, sometimes associated with granite, recorded both on hills or breakaways and on plains.

Phenology. Flowers: July to September. Fruits recorded in August and September.

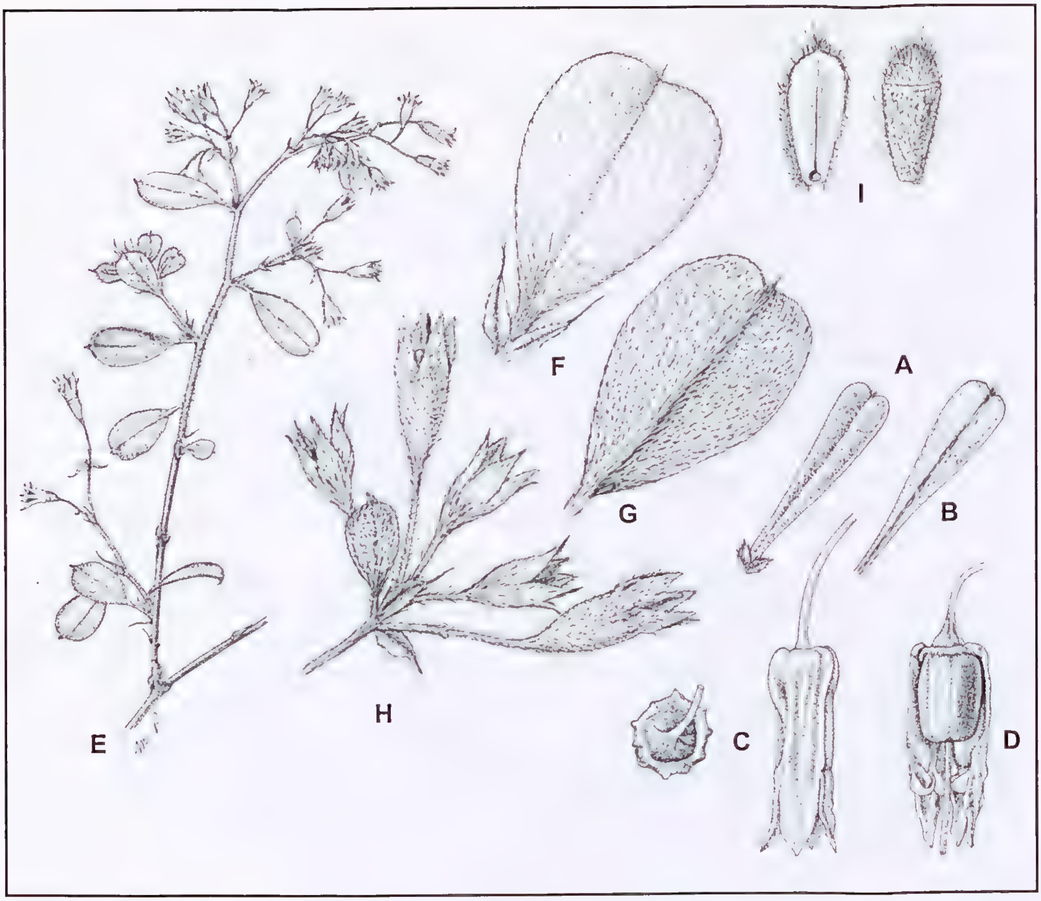


Figure 2. A–D. *Blackallia nudiflora*. A – stipules and upper surface of leaf (×6), B – lower surface of leaf (×6), C – pedicellate flower from basal and side views (×6), D – fruit, with half the enclosing floral tube removed (×6); E–I. *Serichonus gracilipes*. E – flowering and fruiting branch (×1), F – stipules and upper surface of leaf (×4), G – lower surface of leaf (×4), H – cluster of flowers and fruits (×3), I – inner and outer surfaces of fruitlet (×6). Drawn from *C. Chapman s.n.* (A–D) and *R.J. Cranfield* 3098 (E–I).

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. Known from *c.* 12 localities with a range of *c.* 30 km and a single isolated locality *c.* 250 km to the south-east. The southern variant is probably at risk and should be highlighted for studies of its conservation status.

Etymology. From the Latin *nudus* (naked) and *flos* (flower), referring to the glabrous flower.

Typification. A well preserved specimen of the Port Gregory collection by Oldfield at MEL is selected as lectotype (Figure 3). This collection is also represented with duplicates in MEL and K. The Murchison River collection is only known from two specimens at MEL and K. The K specimens from both localities are mounted on the same sheet.

Notes. The southern material of *Blackallia nudiflora*, from the Moora area, is widely disjunct from the remainder of the species range, and differs slightly in that its ovary is not fully superior. Possibly it should be recognised as a distinct subspecies, but it is too poorly known currently to be sure of its status. The lack of recent collections suggests that this variant is either extinct or highly threatened.

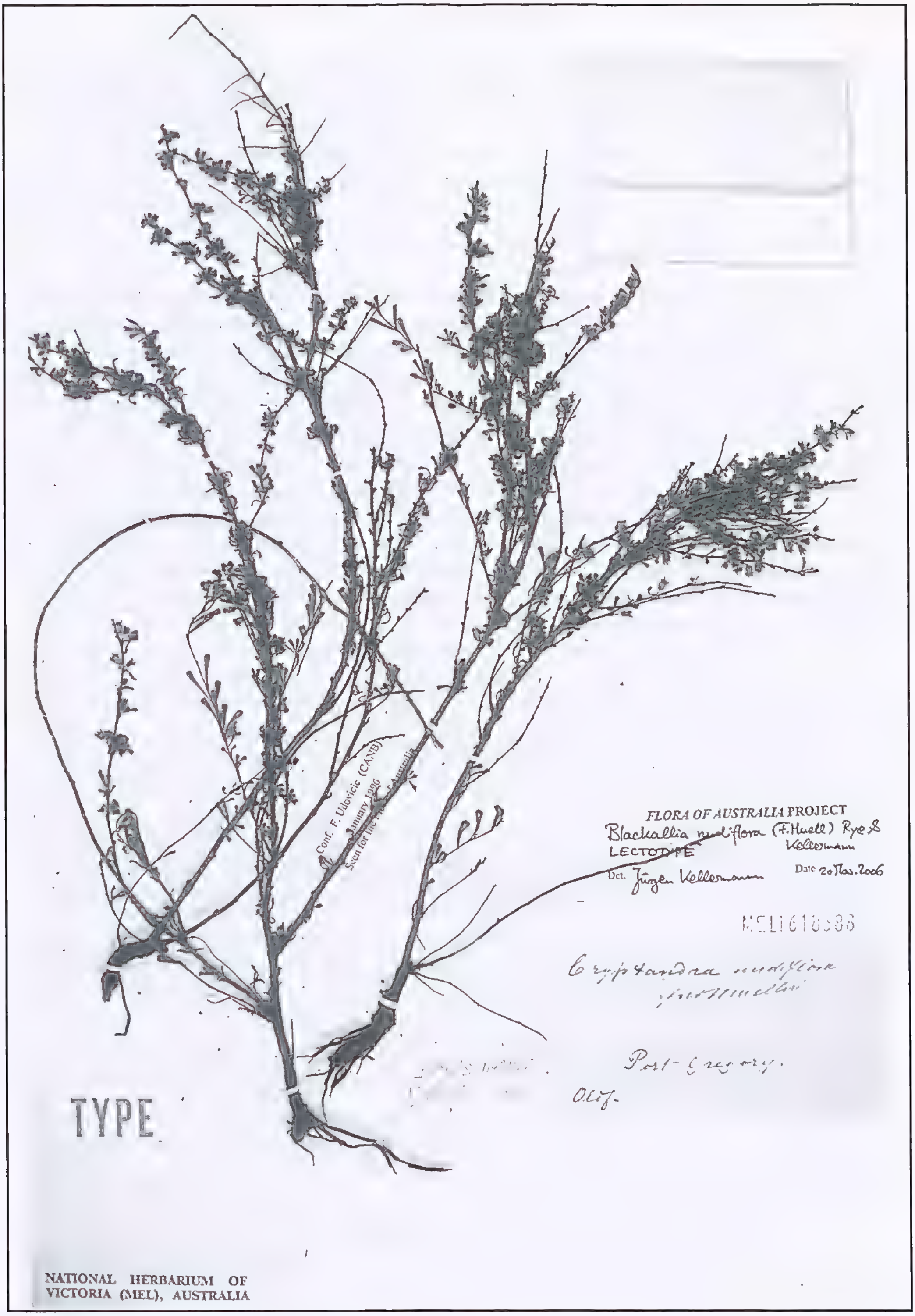

FLORA OF AUSTRALIA PROJECT
Blackallia nudiflora (F.Muell.) Rye & Kellermann
LECTOTYPE
Det. Jürgen Kellermann
Date 20 Mar. 2006
MEL1618388
Cryptandra nudiflora ferd mueller
Port Gregory.
Olf.
Conf. F. Udovicic (CANB)
January 1996
Seen for the Flora of Australia
TYPE
NATIONAL HERBARIUM OF
VICTORIA (MEL), AUSTRALIA

Figure 3. *Blackallia nudiflora*. Photograph of lectotype: Port Gregory, *A.F. Oldfield s.n.* (MEL 1618388).

Papistylus Kellermann, Rye & K.R. Thiele, *gen. nov.*

Fruitices molliter pubescentes. Stipulae persistentes, liberae vel ad basim breviter connatae inter petiolum et caulem. Folia conduplicata vel aperiens. Inflorescentiae capituliformes, cymis contractis formantes. Flores fusiformes, sessiles, pilis simplicibus mollibusque vestiti. Discus glaber, sinuosus, ovarium basin cingens. Ovarium triloculatum vertice dense stellato-tomentoso. Schizocarpium coccis tribus, his findentibus secus superficiem internum.

Typus: Papistylus grandiflorus (C.A. Gardner) Kellermann, Rye & K.R. Thiele.

Small evergreen *shrubs*, softly pubescent with simple hairs. *Stipules* free or very shortly connate at base between the petiole and stem, ± persistent. *Leaves* alternate, shortly petiolate, discolorous, entire. *Inflorescences* mostly terminal, comprising densely contracted many-flowered cymes surrounded by large broad persistent brown bracts. *Flowers* bisexual, 5-partite, white or cream, sessile or subsessile. *Hypanthium* long, tubular, fusiform; free tube much longer than adnate base. *Sepals* erect to spreading, persistent in fruit. *Petals* erect, cucullate, shortly clawed, smooth; claw not adnate to base of stamen filament. *Stamens* enclosed in and subequal to the petals, erect to incurved. *Disc* forming a narrow undulate ring around the ovary summit, free, glabrous, becoming circular in fruit. *Gynoecium* of 3 carpels; ovary inferior or largely inferior, densely hairy on summit; style entire, glabrous, prominently papillose for most of its length, apex with 3 stigmatic lobes. *Fruit* a schizocarpic capsule, *c.* half-inferior or largely inferior, obovoid; fruitlets crustaceous, splitting longitudinally along their inner surface and over the summit to release the seed. *Seeds* arillate; body uniformly coloured above a darkened base; aril moderately large, translucent, 3-lobed.

Size and distribution. A genus of two species, endemic to the south-west of Western Australia.

Etymology. From the Latin *papilla* (nipple) and *stylus* (column), in reference to the markedly papillose style.

Notes. The unusual stylar papillae in *Papistylus* are larger and more prominent than the ones found in *Serichonus*. These two genera appear to be close to *Stenanthemum* but differ in disc type as well as their fruit tending not to be fully inferior and their non-mottled seeds. Stellate hairs are less obvious in *Papistylus* than in the other genera. *Papistylus* appears to have all of its hairs simple on the stems and lower surface of the leaves, but close examination reveals minute stellate hairs hidden beneath the densely silky lower surface of the leaves, at least in *P. grandiflorus*. The minute stellate hairs on the floral tube and sepals are less conspicuous in *P. grandiflorus* than in most taxa of other genera.

Papistylus appears to lack the crystal layer between the fruitlets that occurs in *Serichonus*, however, the fruits are unknown in *P. intropubens* and mostly immature on specimens of *P. grandiflorus*.

Key to species of *Papistylus*

1 Leaves flat, conduplicate at first, apex recurved; floral tube glabrous inside (Carnamah area to Wongan Hills) .... **P. grandiflorus**
1: Leaves with recurved to revolute margins, apex straight; floral tube with fine hairs inside (Boddington area) .... **P. intropubens**

Papistylus grandiflorus (C.A. Gardner) Kellermann, Rye & K.R. Thiele, *comb. nov.*

Cryptandra grandiflora C.A. Gardner, *J. Roy. Soc. Western Australia* 27: 183 (1942). *Type:* west of Carnamah, Western Australia, September 1934, *E.M. Barker* 17 (*holo:* PERTH 01599283; *iso:* PERTH 01599267, 01599275, 01599291).

Illustrations: W.E. Blackall & B.J. Grieve, *How Know W. Austral. Wildfl.*, 1st edn, 2: 337 (1956) [as *Cryptandra grandiflora*]; B.J. Grieve, *How Know W. Austral. Wildfl.*, 2nd edn, 2: 296 (1998) [as *Stenanthemum grandiflorum*].

Shrubs 0.3–0.8 m high, not spinescent, the leaves mostly distant. *Young stems* with dense, silvery or rusty, simple appressed hairs *c.* 0.5 mm long. *Stipules* narrowly triangular, 2–3.5 mm long, free or very shortly connate at base between the petiole and stem, acuminate, denticulate, with simple hairs along midvein and on margins. *Petioles* 1–2 mm long, densely hairy. *Leaf blades* conduplicate at first, narrowly obovate to obovate, (5–) 7–10 (–18) mm long, 2–4 (–7) mm wide, base narrowly cuneate, apex obtuse to acute, the apical point dark, recurved; lower surface with simple, silvery or rusty appressed hairs overlying minute stellate hairs, densely hairy when immature, becoming sparsely hairy or glabrous; upper surface glabrous at maturity, sometimes with few hairs remaining on midrib. *Inflorescence* of contracted many-flowered cymes, globular in shape, 5–15 (–20) mm wide, containing 10–50 flowers, the flowers mostly sessile within 2 floral bracts at the summit of a peduncle *c.* 0.5 mm long; flowers white or (usually) pale pink, moderately villose. *Involucral bracts* larger than the floral bracts, mostly broadly obovate but the outermost bract often with a reduced leaf attached and then 2-lobed above the free petiole. *Floral bracts* obovate or broadly obovate, the base clawed, 3–3.5 mm long, toothed, ciliate, keeled, the outer surface rather densely appressed-hairy along middle and less densely so on the sides. *Floral tube* 1–2.5 mm long (enlarging to *c.* 4 mm long in fruit), 1.5–3 mm in diameter, glabrous inside; adnate base with a dense indumentum of antrorse simple hairs, the largest hairs *c.* 0.7 mm long; free tube longer than base and less densely hairy. *Sepals* 2–2.5 mm long, with an indumentum similar to that of floral tube. *Petals* 0.8–1.2 mm long. *Disc* forming a conspicuous rim around the ovary summit. *Ovary* largely inferior; summit densely covered by erect hairs *c.* 0.5 mm long. *Style* 2.5–5 mm long, thickened in lower half, with stalked papillae *c.* 0.05 mm long, with simple hairs on basal quarter of style. *Fruit* 3–3.5 mm long, *c.* 2 mm in diameter, largely inferior. *Seeds* *c.* 1.7 long, 0.9–1 mm wide, darkened at base, light to medium brown above, not mottled but with the margin slightly paler than the rest; aril *c.* 0.5 mm long, white-translucent, 3-lobed. (Figure 4A–E)

Other specimens examined. WESTERN AUSTRALIA [precise localities withheld]: NW of Watheroo, 30 Aug. 1995, *P. Armstrong s.n.* (PERTH); near Coorow, 14 Sep. 1932, *W.E. Blackall* 2592 (PERTH); S Eneabba, W of Watheroo, *c.* 150 miles [*c.* 241 km] N of Perth, 6. Sep. 1968, *C. Chapman* B (PERTH); Wongan Hills, 11 Sep. 1926, *E.H. Ising s.n.* (AD) & 13 Sep. 1947, *R.D. Royce* 2195 (PERTH); off South Waddi Rd, 15 Sep. 2001, *J. Kellermann* 275 (MEL) & 30 Aug. 1996, *D. Papenfus* 525 *& A. Doley* (PERTH); N of Kalguddering Siding, 23 July 1953, *R. Melville* 4327 (MEL); Read Rd, N of Coorow–Latham road, 31 Aug. 1996, *D. Papenfus* 530 *& R. Anderson* (PERTH); Reserve on Gunyidi–Wubin road, 2 Sep. 1996, *D. Papenfus* 537 (PERTH); S of Carot Well Rd, 11 Sep. 1993, *S.J. Patrick* 1527 (PERTH); uncleared block of land on "Yo Espro", NE of Watheroo, 4 Sep. 2001, *S.J. Patrick* 3990 (PERTH); "Yo Espro" private property of B. & G. Scott, *c.* 5 km WNW of Watheroo, 18 Oct. 1997, *S. Patrick & D. Papenfus* A9 (PERTH); E of Coorow, towards Maya, 13 Sep. 1968, *M.E. Phillips* 933 *& W. Lee* (CBG @ CANB; PERTH); Coorow, 12 Aug. 1955, *R.D. Royce* 5049 (PERTH).

Distribution. Endemic to the South West Botanical Province of Western Australia, extending from west of Carnamah south-east to Wongan Hills. (Figure 1B)

Habitat. Occurs in sandy clay, usually in woodlands but one record from a low shrubland associated with granite.

Phenology. Flowers and fruits: August to November.

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. This species is believed to be at risk because it occurs in an agricultural region that has been largely cleared and is not known from any conservation reserves. Its known range extends *c.* 160 km.

Etymology. From Latin *grandis* (large) and *flos* (flower), referring to the large flowers of the species.

Typification: Type material collected by E.M. Barker is mounted on four sheets at PERTH. The holotype differs from the rest in having line illustrations drawn directly on the sheet by Gardner and also in having a tag attached by string to the specimen. The tag is labelled *Cryptandra* on one side and has the number 17 on the reverse side. Gardner stated in the introduction to his paper that the types of most taxa had been donated to the State Herbarium. This is the only specimen that has the State Herbarium label on it, and it is also labelled "Type".

The other three sheets have no tags or annotations by Gardner but have the same collection details and matching plant material. These specimens were originally in the W.E. Blackall collection and Herbarium Gardnerianum; one came to PERTH from Blackall's collection and is labelled "Isotype". As these three specimens appear to be part of the same collection they are considered to be isotypes.

Notes. The name '*Stenanthemum grandiflorum* (C.A.Gardner) Rye ms.' has been applied to this taxon by Grieve (1998), FloraBase (Western Australian Herbarium 1998–), Paczkowska & Chapman (2000), Kellermann *et al.* (2005) and Kellermann & Udovicic (2007).

Papistylus intropubens Rye, *sp. nov.*

Differt a *Papistylo grandifloro* a foliis fere linearibus vel anguste ovato, margine recurvato vel revoluto, tubo hypanthii intra pubescenti.

Typus: 10 km S of Boddington [precise locality withheld], Western Australia, 14 August 1982, *K.J. Atkins* 309 (*holo:* PERTH 01516884).

Shrubs erect, slender, *c.* 0.5 m high, not spinescent, the leaves mostly distant. *Young stems* with simple, appressed or antrorse, greyish hairs, the longer ones *c.* 0.5 mm long. *Stipules* narrowly triangular, 1–2 mm long, free, positioned between the petiole and the stem, acuminate, sparsely hairy on outer surface. *Petioles* 0.6–1.5 mm long, densely hairy on undersurface. *Leaf blades* not conduplicate, almost linear to very narrowly ovate, 6–10 mm long, 0.8–1.5 mm wide, entire, the margins recurved or revolute; base obtuse, apex acute, straight; lower surface largely concealed by the recurved margins, densely covered at first by appressed to antrorse simple hairs, often becoming less densely hairy; upper surface smooth, glabrous. *Inflorescence* of contracted many-flowered cymes, 9–15 mm wide, with *c.* 20 flowers; involucral bracts more or less circular, *c.* 3 mm long, acute, denticulate or minutely laciniate, prominently ciliate, the cilia *c.* 0.5 mm long, the outer surface sparsely hairy. *Floral bracts* similar to involucral bracts but smaller. *Floral tube c.* 3.5 mm long, with fine, simple hairs, the largest ones *c.* 0.7 mm long; adnate portion of tube 2.5–3 mm long, 1–1.5 mm in diameter, sparsely silky-hairy outside and with fine tangled hairs *c.* 0.3 mm long inside. *Sepals* 0.8–1 mm long, densely hairy;

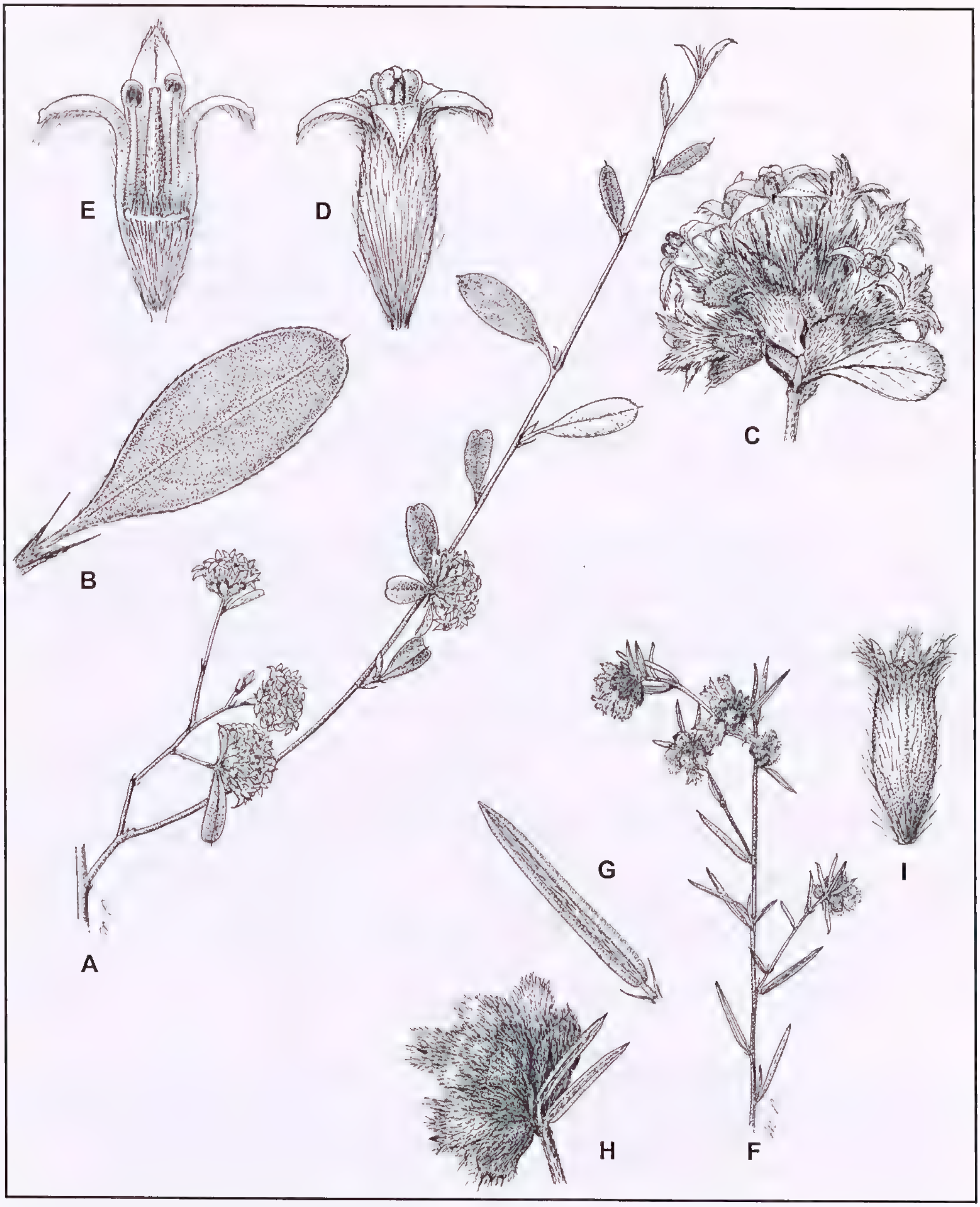


Figure 4. A–E. *Papistylus grandiflorus*. A – flowering branch (×1), B – stipules and leaf (×4), C – flower cluster (×3), D – flower (×6), E – flower partially dissected to show disc, ovary hairs and style papillae (×6); F–I. *Papistylus intropubens*. F – flowering branch (×1), G – stipules and lower surface of leaf (×4), H – flower cluster (×4), I – flower (×6). Drawn from *M.E. Phillips* 13 Sep. 1968 (A–E) and *K.J. Atkins* 309 (F–I).

hairs simple, spreading, *c.* 0.5 mm long. *Petals c.* 0.7 mm long. *Disc* annular, free, glabrous, forming a conspicuous free rim around the ovary roof at the base of the hypanthium. *Ovary* inferior; summit with a dense indumentum of tangled hairs up to 1 mm long. *Style* 2.5–3 mm long, with broad, rounded patent papillae *c.* 0.05 mm long. *Fruit* unknown. (Figure 4F–I)

Distribution. Endemic to the South West Botanical Province of Western Australia. Known only from a single collection from near Boddington. (Figure 1A)

Habitat. Recorded in heath vegetation.

Phenology. Flowers recorded in August.

Conservation status. Conservation Codes for Western Australian Flora: Priority One. Two unsuccessful attempts have been made to relocate the species at its only known locality. Vegetation of the area where it occurred was very dense when revisited by Kevin Kenneally (pers. comm.), who suggested that the species might require more open conditions and that disturbance might favour its reappearance. If it is primarily a coloniser species, this could help explain its rarity, but if not, the species could possibly be extinct.

Etymology. From the Latin *intro* (internal) and *pubens* (hairy), in reference to the floral tube of the species that is pubescent inside.

Notes. This very poorly known species was previously known by the phrase name *Cryptandra* sp. Boddington (*K.J. Atkins* 309). Its description is based on a single specimen that was in flower, but had no fruits. It appears to be closely related to *Papistylus grandiflorus*, which differs in having leaves with flat to incurved margins and the floral tube glabrous inside. *Papistylus intropubens* is the only species in the Pomaderreae known to have the inside of the floral tube hairy.

Serichonus K.R. Thiele, *gen. nov.*

Fruitices molliter pubescentes. Stipulae persistentes, convenientes vel ad basim breviter connatae inter petiolum et caulem. Folia primum conduplicata deinde aperientia, margine plano. Inflorescentiae terminales, paniculis cymosis laxis formantes. Flores infundibuliformes, longi-pedicellati, pilis simplicibus vestiti. Discus glaber, sinuosus, ovarium basin cingens. Ovarium triloculatum vertice dense stellato-tomentoso. Fructus pedicello quam flore multo magis longiore (usque ad triplex). Schizocarpium coccis tribus, his findentibus secus superficiem internum.

Typus: Serichonus gracilipes (Diels) K.R. Thiele.

Evergreen *shrubs*, softly and densely pubescent with both simple and stellate hairs, sometimes with adventitious roots. *Stipules* free or shortly connate at base between the petiole and stem, broad, ± persistent. *Leaves* alternate, petiolate, discolorous, entire, conduplicate when young, margins flat. *Inflorescences* mostly terminal, comprising small, loose, few-flowered, cymose panicles; bracts persistent. *Flowers* bisexual, 5-partite, cream when young, often reddening with age, long-pedicellate, the pedicels elongating significantly in fruit. *Hypanthium* shortly tubular, funnel-shaped. *Sepals* erect to spreading, persistent in fruit. *Petals* erect, cucullate, shortly clawed, smooth; claw adnate to base of stamen filament for part of its length. *Stamens* enclosed in and subequal to the petals, erect to incurved. *Disc* forming a narrow, undulate ring around the ovary summit, free, glabrous, becoming circular in fruit. *Gynoecium* of 3 carpels; ovary ± inferior, densely stellate-hairy on summit; style entire, glabrous, papillose for most of its length, apex with three minute stigmatic lobes. *Fruit* a schizocarpic capsule, *c.* half-inferior or largely inferior, obovoid; fruitlets crustaceous, with a crystal layer between the fruitlets, splitting longitudinally along their inner surface and over the summit to release the seed. *Seeds* arillate; body uniformly coloured above a darkened base; aril moderately large, translucent, 3-lobed.

Size and distribution. A monotypic genus restricted to the area north of Geraldton in the south-west of Western Australia.

Etymology. From the Greek *serikon* (silk) and *chonos* (a funnel), in reference to the silky-pilose, funnel-shaped flowers.

Notes. This monotypic genus is similar to *Papistylus* in leaf shape and indumentum, in its long floral tube and papillose style (the papillae being more prominent in *Papistylus*). It is similar to *Blackallia* in its long-pedicellate flowers with a long floral tube and in its fruit, but is readily distinguished as outlined under that genus.

A unique character in *Serichonus* is the open lax inflorescence with pedicels that enlarge significantly, by up to three times, in fruit. In other genera of Pomaderreae the pedicels extend to at most twice their original length. There is also a distinct crystal layer on the inner surface of the fruitlets, which presumably aids in the splitting of the schizocarp; this has not been observed in *Blackallia* or *Papistylus*. Adventitious roots seem to be extremely rare among the Pomaderreae, but do occur in *Serichonus.*

The petals and stamens in *Serichonus gracilipes* are fused for *c.* 0.3 mm at the base, a feature infrequently observed in Rhamnaceae; examples of Australian species with fused petal-stamen-complexes are *Pomaderris adnata* (Walsh & Coates 1997) and *P. subplicata* (Walsh 1992). Bennek (1958) argued that petals and stamens in Rhamnaceae, which arise adjacent to each other (obhaplostemonious) rather than alternating as in most other families, develop from a common primordium. However, other authors (e.g. Ronse Decraene *et al.* 1993) dispute this, believing that separate petal and stamen primordia become secondarily fused (see also Medan & Schirarend 2004). Morphological studies on *Serichonus* and other species of Pomaderreae might help to resolve the developmental pathways that lead to the obhaplostemonious flowers in Rhamnaceae.

Serichonus gracilipes (Diels) K.R. Thiele, *comb. nov.*

Stenanthemum gracilipes Diels *in* L. Diels & E. Pritzel, *Bot. Jahrb.* 35: 356–357, Fig. 45E–H (1904). – *Cryptandra gracilipes* (Diels) C.A. Gardner, *Enum. Pl. Austral. Occ.* 3: 77 (1931). *Type citation*: "Hab. in distr. Irwin pr. Champion Bay in collibus quos vocant Wokatherra Hills in fruticeis lapidoso-glareosis deflor m. Sept. (D[iels]. 4183)." *Type:* Wokatharra Hills, near Champion Bay, Western Australia, 9 September 1901, *L. Diels* 4183 (*lecto:* PERTH 1008188, ex B, here designated).

Illustrations: L. Diels & E. Pritzel, *Bot. Jahrb.* 35: 358, Fig. 45E–H (1904); L. Diels, *Pflanzenw. W. Austral.*, 174, Fig. 41E–H (1906) [both as *Stenanthemum gracilipes*]; W.E. Blackall & B.J. Grieve, *How Know W. Austral. Wildfl.*, 1st edn, 2: 334 (1956) [as *Cryptandra gracilipes*]; B.J. Grieve, *How Know W. Austral. Wildfl.*, 2nd edn, 2: 596 (1998) [as *Stenanthemum gracilipes*].

Shrubs 0.2–0.7 m high, with sprawling stems sometimes layering, not spinescent, the leaves mostly distant. *Young stems* with a dense indumentum at first of long simple and smaller stellate hairs, sometimes becoming glabrous; simple hairs mostly antrorse, the longest ones 0.7–1.5 mm long. *Stipules* broadly triangular, 3–5.5 mm long, free or connate at the very base between petiole and stem, attenuate, denticulate, hairy along midvein and on margins. *Petioles* 2–4 mm long, densely hairy. *Leaf blades* conduplicate at first, obovate, 12–20 mm long, 7–12 mm wide; base cuneate, apex emarginate and apiculate, slightly recurved; lower surface densely pilose with long simple hairs overlying smaller stellate hairs; upper surface with a sparse to moderately dense indumentum of simple hairs.

Inflorescence of loose cymes, each terminating a branchlet and commonly 3–6 (–10)-flowered; outer bracts solitary, persistent, each subtending a group of pedicels, ovate or broadly ovate, 1.5–2.5 mm long, toothed, ciliate, somewhat hairy on outer surface, the hairs simple and appressed; bracts at the base of pedicels small, 0.2–0.8 mm long. *Flowers* white, becoming red or pink in fruit, the pedicel usually 3–6 mm long (enlarging to 7–12 mm in fruit). *Floral tube* 1.5–2 mm long (enlarging to *c.* 3 mm long in fruit), 1.5–2.3 mm in diameter, funnel-shaped, glabrous inside; base of hypanthium with a dense or very dense indumentum of antrorse simple hairs and much smaller stellate hairs, the largest hairs *c.* 1 mm long; floral tube much longer than base and less densely hairy, sometimes largely glabrous with hairs restricted to the 5 longitudinal veins. *Sepals* 1.5–2 mm long, moderately to densely hairy. *Petals* 1–1.2 mm long (excluding adnate base), white with dark pink spots above; claw adnate to base of stamen filament for 0.2–0.3 mm. *Stamens* 0.8–1.1 mm long (excluding adnate base), the anther 0.25–0.3 mm long. *Disc* smooth, yellow. *Ovary* summit with a dense indumentum of long tangled erect hairs. *Style* 1.6–2.5 mm long, with papillae *c.* 0.02 mm long; stigma minutely 3-lobed. *Fruit* largely inferior to about half-inferior, 2.3–3 mm long, reddish-brown. *Seeds* compressed, elliptic in outline, 2.3–2.4 mm long, body *c.* 1.9 mm long and *c.* 1.1 mm wide, darkened at base, uniformly orange-brown above; aril clear-translucent, *c.* 0.7 mm long, shortly 3-lobed. (Figure 2E–I)

Other specimens examined. WESTERN AUSTRALIA [precise localities withheld]: *c.* 18 km N of Geraldton, 25 Aug. 1997, *P.G. Armstrong s.n.* (PERTH); S of Northampton towards Nanson, SE of Highway, 21 Aug. 1983, *R.J. Cranfield* 2670 (PERTH); W of North West Coastal Highway, 29 Aug. 1983, *R.J. Cranfield* 3098 (PERTH); 21 miles [34 km] N of Geraldton, 9 Sep. 1966, *A.S. George* 7945 (PERTH); Moresby Range, 8 July 2000, *S. Hopper* 10 (PERTH); Isseka Rd, S of Northampton, 13 Sep. 2001, *J. Kellermann* 262 *& I.B. Shepherd* (MEL) & 18 July 2000, *I.B. Shepherd* 230 (PERTH); S of Port Gregory Rd, 14 Aug. 1996, *S.J. Patrick* 2723 (PERTH); near Mt Rennie, 20 Aug. 2003, *B.L. Rye* 238064 & 238065 *& M.E. Trudgen* (PERTH).

Distribution. Endemic to the South West Botanical Province of Western Australia, extending from Nabawa south to Wokatharra Hill. (Figure 1B)

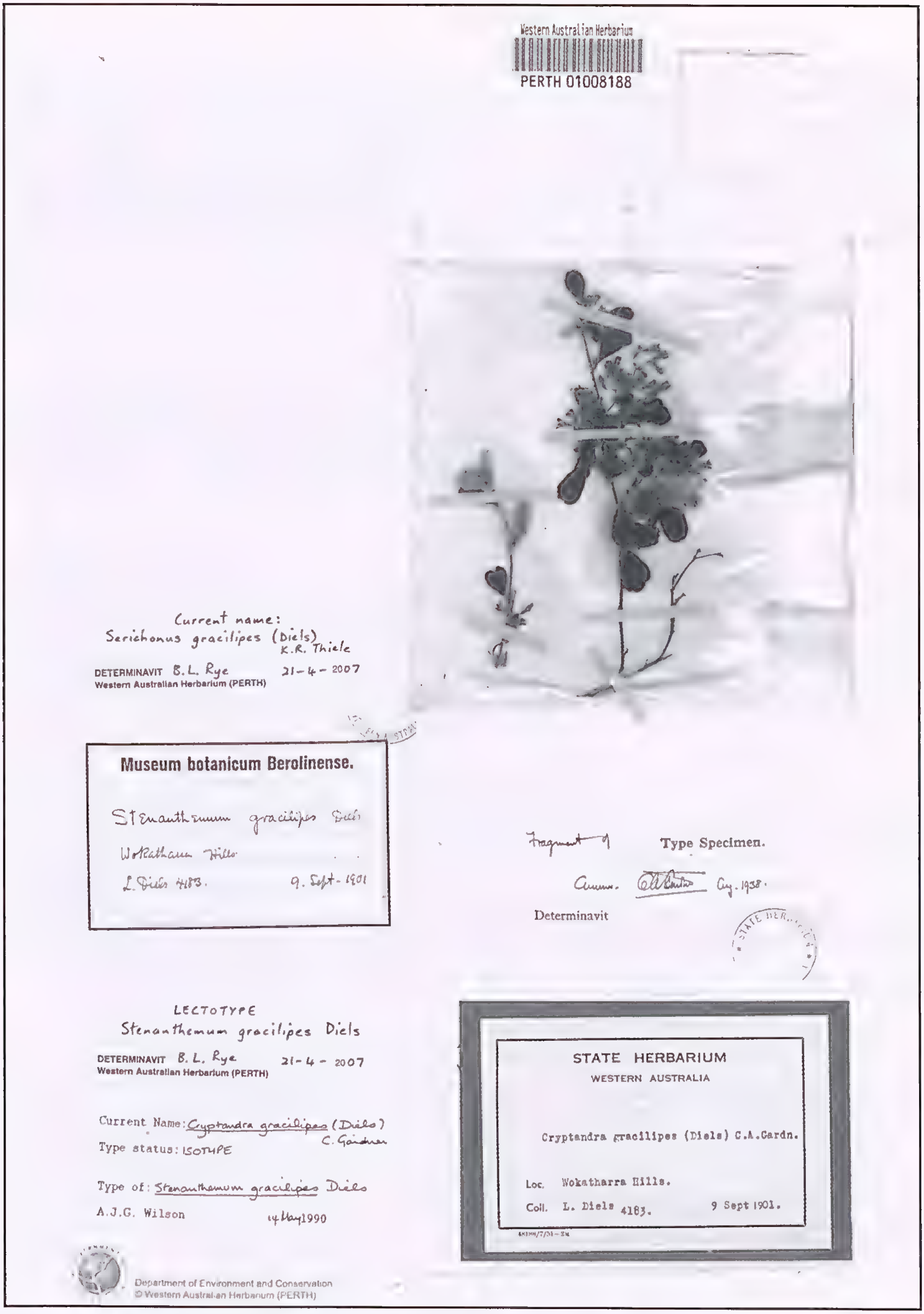
Habitat. Occurs in rocky habitats, usually in laterite on granite, but also recorded from sandstone. One record is from rock crevices on the margins of the flat summit of a laterite mesa dominated by *Hibbertia* and other wind-pruned shrubs and extending down top part of the steep side. Earlier records include the basal slopes of mesas, granite outcrops or sheets with *Thryptomene* (sometimes next to granite boulders) and rocky gullies.

Phenology. Flowers and fruits recorded in August and September.

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. Known from less than ten localities, but more than five, with a range of *c.* 30 km. Not known from any nature reserves.

Etymology. From the Latin *gracilis* (slender) in reference to the loose inflorescences of the species.

Typification. Diels' original collection from his travels in Western Australia (see Diels 1904–1905, 1906), including the holotype of *Stenanthemum gracilipes*, was held at B, most of which was destroyed at the end of the second World War. A search for the type at this institution was unsuccessful (R. Vogt, pers. comm., June 2006). A type fragment at PERTH, acquired by C.A. Gardner from B in the 1930s, is here designated as the lectotype (Figure 5).



Western Australian Herbarium
PERTH 01008188

Current name:
Serichonus gracilipes (Diels) K.R. Thiele
DETERMINAVIT B.L. Rye 21-4-2007
Western Australian Herbarium (PERTH)

Museum botanicum Berolinense.
Stenanthemum gracilipes Diels
Wokatharra Hills
L. Diels 4183. 9. Sept. 1901

Fragment of Type Specimen.
Aug. 1938.
Determinavit

LECTOTYPE
Stenanthemum gracilipes Diels
DETERMINAVIT B. L. Rye 21-4-2007
Western Australian Herbarium (PERTH)

Current Name: Cryptandra gracilipes (Diels) C. Gardner
Type status: ISOTYPE

Type of: Stenanthemum gracilipes Diels
A.J.G. Wilson 14 May 1990

STATE HERBARIUM
WESTERN AUSTRALIA
Cryptandra gracilipes (Diels) C.A.Gardn.
Loc. Wokatharra Hills.
Coll. L. Diels 4183. 9 Sept 1901.

Department of Environment and Conservation
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Figure 5. *Serichonus gracilipes*. Photograph of lectotype: Wokatharra Hills, near Champion Bay, 9 September 1901, *L. Diels* 4183 (PERTH 1008188).

Discussion

Blackallia and *Papistylus* form a clade, with very high bootstrap and jackknife support, in cladograms based on ITS sequence data (Kellermann *et al.* 2005). *Serichonus*, however, was intercalated between two clades of *Stenanthemum* in these analyses, albeit with very low support values. New evidence from combined analyses of ITS and *trn*L-F sequence data (Kellermann 2007) firmly places *Serichonus* as sister taxon to the clade of *Blackallia* and *Papistylus*, with high statistical support. Analysis of the *trn*L-F region alone also supports this finding, but was, as a whole, impeded by the paucity of informative characters and the presence of homoplasious indel characters (Kellermann & Udovicic 2007).

Placing *Serichonus* as sister taxon to the *Blackallia-Papistylus* clade is corroborated by morphological data, which is at odds with the placement of *Serichonus* in *Stenanthemum* (Kellermann *et al.* 2005). The latter genus has sessile to subsessile flowers arranged in dense, contracted head-like cymes subtended by bracts and leaves (Rye 1995a, 2001, Thiele 2007). In some species the inflorescence is surrounded by whitish floral leaves. The flowers have a short or long free floral tube with a disc lining the floral tube, confluent with the filament bases and shallowly to deeply indented between the stamens. The ovary is inferior and remains so in fruit. Seeds in *Stenanthemum* are mottled in brown and off-white.

In contrast, *Serichonus*, *Papistylus* and *Blackallia* have a long floral tube, and a free, glabrous, undulating disc inserted at the junction of the free floral tube and ovary. Seeds are uniformly coloured in all three genera. *Blackallia* and *Serichonus* have long-pedicellate flowers in cymose inflorescences, which are densely contracted at short shoots, or arranged in loose cymose panicles, respectively. *Papistylus* has more or less sessile flowers arranged in contracted head-like cymes. The ovary and fruit are superior or largely superior in *Blackallia*, whereas they are *c.* half to fully inferior in *Papistylus* and *Serichonus*. Floral leaves are absent in all three genera.

Inflorescence structure and disc type are particularly important generic characters in Pomaderreae, with ovary position and seed colouring also significant. The three genera do not fit the current circumscriptions of *Stenanthemum* or *Cryptandra* (see Rye 2007, Thiele 2007, Thiele & West 2004), in which their species were placed previously. *Blackallia*, *Serichonus* and *Papistylus* share with *Cryptandra* uniformly coloured seeds and a similar disk structure; however *Cryptandra* is characterised by a stellate-hairy disc and unique stipules, which are united at the base on the abaxial side of the petiole and tend to hide the base or whole of the petiole from view. *Cryptandra* has solitary flowers, which are usually sessile or subsessile and subtended by a series of floral bracts. The flowers in *Blackallia*, *Serichonus* and *Papistylus*, by contrast, are arranged in cymose inflorescences with a cymose bract pattern.

The three genera described in this paper have the same fruit type that characterises *Stenanthemum* and *Cryptandra* and could be placed between them on both morphological and molecular grounds. The molecular analysis of Kellermann *et al.* (2005) placed *Papistylus* and *Blackallia* as sister taxa to *Cryptandra*, albeit without statistical support. A combined analysis of *trn*L-F and ITS sequence data locates these genera in one clade, which is sister to *Stenanthemum* (Kellermann 2007). *Serichonus*, *Papistylus* and *Blackallia* are considered to be too distinct from one another to be united in an enlarged genus *Blackallia*, since they differ substantially in habit, inflorescence and flower morphology.

Acknowledgements

We thank Irene & Owen Shepherd, who provided hospitality and granted access to their property while collecting *Serichonus gracilipes*. Dr Robert Vogt searched for type material at B. The Western Australian Department of Environment and Conservation (formerly CALM) issued collecting permits to J. Kellermann. The illustrations were drawn expertly by Margaret Pieroni. Neville Walsh (MEL) checked the Latin diagnoses. J. Kellermann was supported by a Melbourne Research Scholarship (MRS) and a Melbourne University Research Development Grant (to P.Y. Ladiges, School of Botany) during part of this project. This paper is written in preparation of the "Flora of Australia" treatment of Rhamnaceae, supported by the Australian Biological Resources Study (ABRS).

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A new species of *Hypoxis* (Hypoxidaceae) from saline wetland margins in Western Australia

Michael N. Lyons and Greg J. Keighery

Department of Environment and Conservation, Wildlife Research Centre,
P.O. Box 51, Wanneroo, Western Australia 6065

Abstract

Lyons, M.N. and Keighery, G.J. A new species of *Hypoxis* (Hypoxidaceae) from saline wetland margins in Western Australia. *Nuytsia* 16(2): 317–320 (2007). A new species, *Hypoxis salina* Lyons & Keighery, is described and illustrated. The species is confined to the margins of naturally saline wetlands in the Mallee Bioregion of southern Western Australia.

Introduction

The Western Australian Department of Environment and Conservation (formerly CALM) undertook a regional biological survey of the Agricultural zone of Western Australia as part of the Western Australian Salinity Action Plan (Government of Western Australia, 2000). During the survey many species and species complexes were noted that required further taxonomic study. This paper forms part of a continuing series publishing the results of these studies.

Hypoxis was revised for Australia by Henderson (1987), where he accepted ten endemic species. Six of these were in section *Hypoxis* and are largely tropical in distribution and four were in section *Ianthe*, which is largely temperate in distribution. All members of section *Ianthe* occur in southern Western Australia and two are endemic to this region.

The new species of *Hypoxis* belongs to section *Ianthe*, being completely glabrous with the anthers attached near their base, at the base of the connective.

Taxonomy

Key to species of *Hypoxis* section *Ianthe* (after Henderson, 1987, p. 180).

1. Plants completely glabrous .... **Sect II. IANTHE**
   8. Bracteoles 2 per axis, never sheathing, filiform, to 1.8 cm long, with 1 nerve or nerve absent .... **H. glabella**
   8. Bracteoles usually 1 per axis and sheathing, 1–7 cm long, with more than 1 nerve **9**

9. Stigmatic lobes usually longer than stylar column; bracteoles 1.5–7 cm long, perianth lobes 4, 5 or 6 .... **10**
    10. Mature capsule obovoid–ellipsoidal , less than 3.5 times as long as wide, stigmatic lobes usually longer than stylar column, perianth lobes 6 .... **H. vaginata** var. **vaginata**
    10. Mature capsule linear, more than 4 times as long as wide, stigmatic lobes usually longer than stylar column, perianth lobes 4, 5 or 6 .... **H. occidentalis**

9. Stigmatic lobes much shorter than stylar column; bracteoles 5–70 mm long, perianth lobes 6 .... **11**
    11. Ovary linear, more then 4 times as long as wide .... **H. gardneri**
    11. Ovary obovoid–ellipsoidal **12**
        12. Ovary obovoid, c. 1 mm long, bracteole 5 mm long .... **H. salina**
        12. Ovary obovoid–ellipsoid, 8–14 mm long, bracteole 10–70 mm long (S.E. Australia) .... **H. vaginata** var. **brevistigmata**

Hypoxis salina M.Lyons & Keighery, *sp. nov.*

Affinis *Hypoxidi vaginatae* sed lobis stigmatis valde brevioribus quam columnam styli, et ovario obovoideo, 1 mm longo; plantis herbaceis, 2-4 cm altis; foliis linearibus, teretibus-semiteretibus, 25-35 mm longis, pedunculo unifloro, unibracteato; lobis perianthio 7 mm longis.

Typus: Chinocup Nature Reserve, 33° 30' S, 118° 23' E, 27 Oct. 2006, *M.N. & S.D. Lyons* 4890 (*holo:* PERTH 07575793; *iso:* CANB, MEL).

Perennial *herb* 2–4 cm high, from a condensed corm, 7–9 mm long, 5–9 mm wide, tunic densely fibrous. Roots fleshy, white and often sand binding. *Leaves* usually two or single, erect with a pronounced bend a the base, slightly bilaterally flattened but appearing terete, glabrous, green but normally reddish, <1 mm wide, 25–35 mm long, soft and succulent, apex acute.0.5–1.0 mm wide, 8–17 mm long. *Inflorescence* a solitary flower, flowering axis 20–25 mm long, 10–14 mm above bracteole, usually reddish in colour. *Bracteole* singular, stem clasping, scarious, c. 5 mm long. *Perianth* lobes, smooth, bright yellow inside, pale yellow outside. *Sepals* narrowly obovate, 7 mm long, c.4 mm wide. *Petals* obovate, 6–7 mm long, 2–3 mm wide, apex acute. *Stamens*, yellow, 2–4 mm long, filaments alternately short and long, anthers c. 2 mm long, shortly lobed at base. *Style* ± clavate, 3–3.5 mm long, including the narrowly triangular lobes, 1–1.5 mm long. *Ovary* obovoid, c. 1 mm long. *Capsule* ± obovoid–ellipsoidal, 3–4 mm long by c.2 mm wide. *Seeds* round, less than 1 mm wide, black, surface papilate, shiny. (Figure 1)

Other specimens examined. WESTERN AUSTRALIA (all PERTH): Chinocup, 11 Oct. 1999, *R. Cugley* 89; Chinocup, 8 Oct. 1999, *M.N. Lyons* 2850; Chinocup, 18 Oct. 2000, *M.N. Lyons* 2851.

Distribution. Recorded from the Mallee Bioregion (Thackway & Cresswell 1995).

Habitat. Occurs within braided saline drainage lines and on the margins of salt lakes on seasonally wet sandy soils in *Melaleuca thyoides* shrubland.

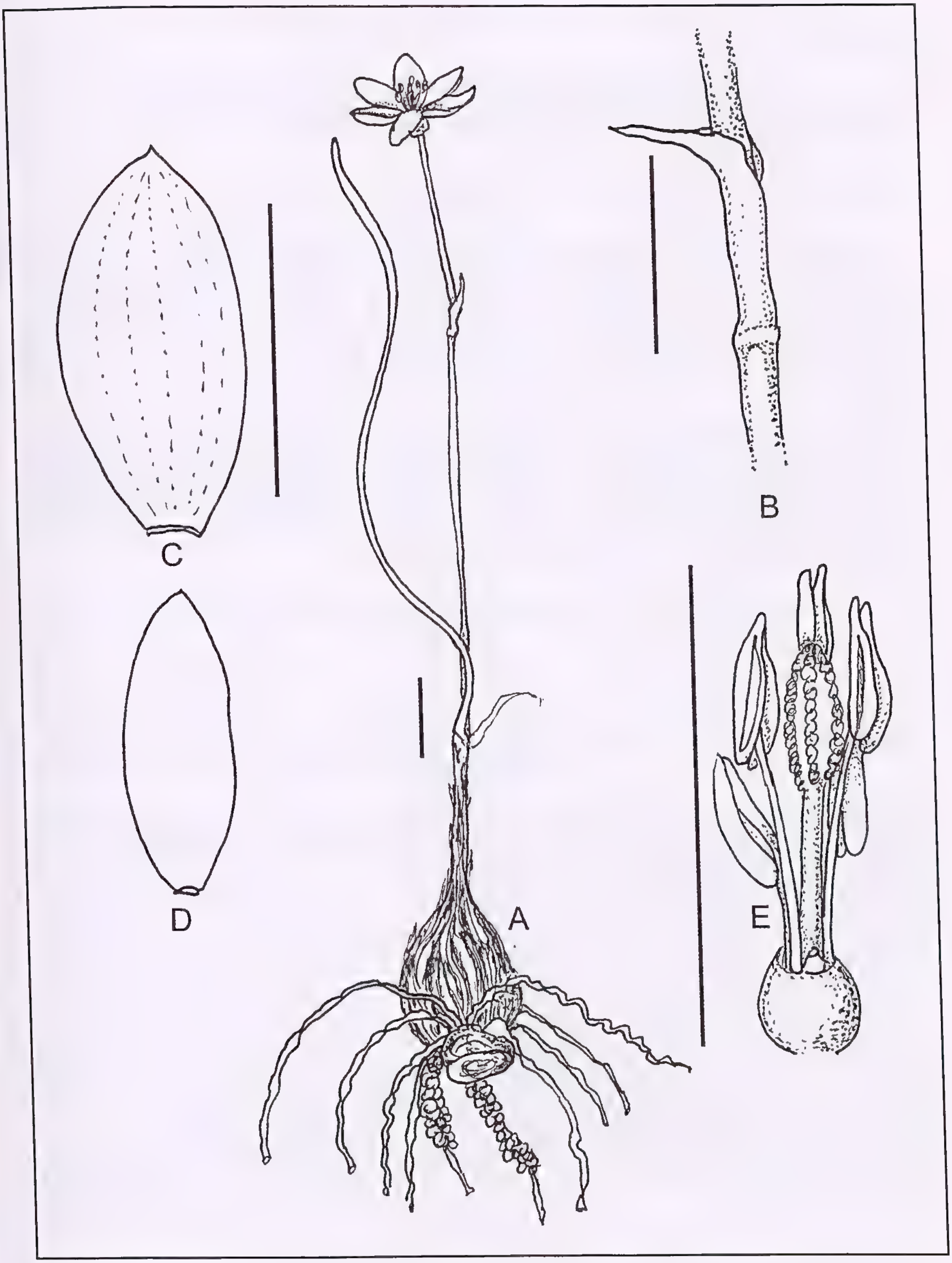

Figure 1. A–E. *Hypoxis salina.* A – whole plant; B – bracteole; C – petal; D – sepal; E – stamens and style (front stamen removed). Drawn from *M.N. & S.D. Lyons* 4890 (PERTH 07575793); scale bar = 5mm.

Flowering period. Flowering in spring, from August to October . Mature fruits and seeds are found in November.

Conservation status. Localised. Represented in at least one nature reserve but under threat from rising saline groundwaters. Conservation Codes for Western Australian Flora: Priority One.

Etymology. From the Greek *salina* – salt, referring to the preferred habitat of this species.

Affinities. This species has a single bracteole which keys this species to a group of related Western Australian taxa (*Hypoxis gardneri* R.J.F.Hend., *H. occidentalis* Benth. and *H. vaginata* Schltdl. var. *vaginata*). The ovoid ovary places this species closest to *Hypoxis vaginata*, as the other members of the complex have a linear ovary. *Hypoxis vaginata* is a taller more robust plant with flattened leaves and stigmatic lobes longer than or equal to the stylar column. The ovary is longer being obovoid–ellipsoidal in shape.

However, on gross morphology the species appears to be part of a species complex related to *Hypoxis glabella* R.Br., which includes this taxon and another unnamed species – '*H.* sp. Beaufort (V. Crowley DKN 629)'. It differs from *Hypoxis glabella* in being smaller, having terete leaves, a single bracteole and the flowers above the leaves. From '*H.* sp. Beaufort (V. Crowley DKN 629)' it differs in the single bracteole, smaller flowers, and the sepaline tepals not brown outside.

Note. This species was previously referred to by the phrase name '*Hypoxis* sp. Chinocup (R. Cugley 89)'.

Acknowledgments

We wish to thank Paul Wlson for his assistance with the Latin diagnosis. The assistance of members of DEC's biological survey unit is acknowledged and funding from the Salinity Action Plan. Simon Lyons provided extensive field assistance during the survey.

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Drosera gibsonii (Droseraceae), a new Pygmy *Drosera* from south-west Western Australia

Phill Mann

P.O. Box 193, Harvey, Western Australia 6220

Abstract

Mann, P. *Drosera gibsonii* (Droseraceae), a new Pygmy *Drosera* from south-west Western Australia. *Nuytsia* 16(2): 321–323 (2007). *Drosera gibsonii* (*Drosera* subgenus *Rorella* section *Lamprolepis*) is described from the Stirling Range National Park. Its closest relative is *Drosera silvicola* Lowrie & Carlquist and the features that distinguish this taxon from *Drosera gibsonii* are presented together with its habitat preferences and conservation status.

Introduction

Drosera gibsonii P. Mann, *sp. nov.*

Drosera silvicola affinis sed scapo usque 3 cm longa, persistens, 7-12 flores, styli 3 malvinus claviformis, pollen luteus, petala sub-roseus-malvinus.

Typus: Stirling Range National Park, Western Australia, 11 November 2006, *P. Mann* 06/001 (*holo*: PERTH 07220731; *iso*: CANB, K, UNE).

Fibrous rooted *herb* forming a semi-erect rosette to 1.25cm diameter. *Stem* to 4 cm long covered with the withered remains of the previous seasons' growth. *Leaves* 6–12. *Lamina* narrow elliptical, 3 mm long by 1.5 mm wide, petiole 5 mm long by 0.75 mm wide at the base, 0.5 mm wide at the apex, lower surface caniculate in cross section. *Stipule bud* ovoid, 7 mm long by 5 mm diameter, with setae. *Stipules* 3-lobed, 6.5 mm long, 3 mm wide, central lobe divided into 4 segments. *Inflorescence* singular, racemose, scape to 3 cm long, covered with minute short-stalked glands, flowers 7–12, pedicels 1.5 mm long covered in minute short-stalked glands, erect in fruit. *Calyx lobes* ovate, 2.5 mm long, 1.5 mm wide, glabrous, apex premorse, serrated, covered with minute short stalked glands. *Petals* pink to mauve, ovate, 8 mm long, 5 mm wide, apex slightly tapered. *Ovary* globular, 1 mm long, 1 mm diameter. *Styles* 3, mauve, 3.5 mm in length, stigma translucent white, claviform. *Stamens* 5, pink – mauve, 5 mm long, anthers and pollen yellow. *Gemmae* 1.5mm long, 1.2 mm wide, 0.75 mm thick. (Figure 1)

Other specimens examined. WESTERN AUSTRALIA [precise locality withheld]: Stirling Range, 25 Sep. 1994, *W. Bopp* 118 (K, PERTH); Stirling Range, 23 Oct. 1991, *W. Greuter* 23125 (?B, PERTH).

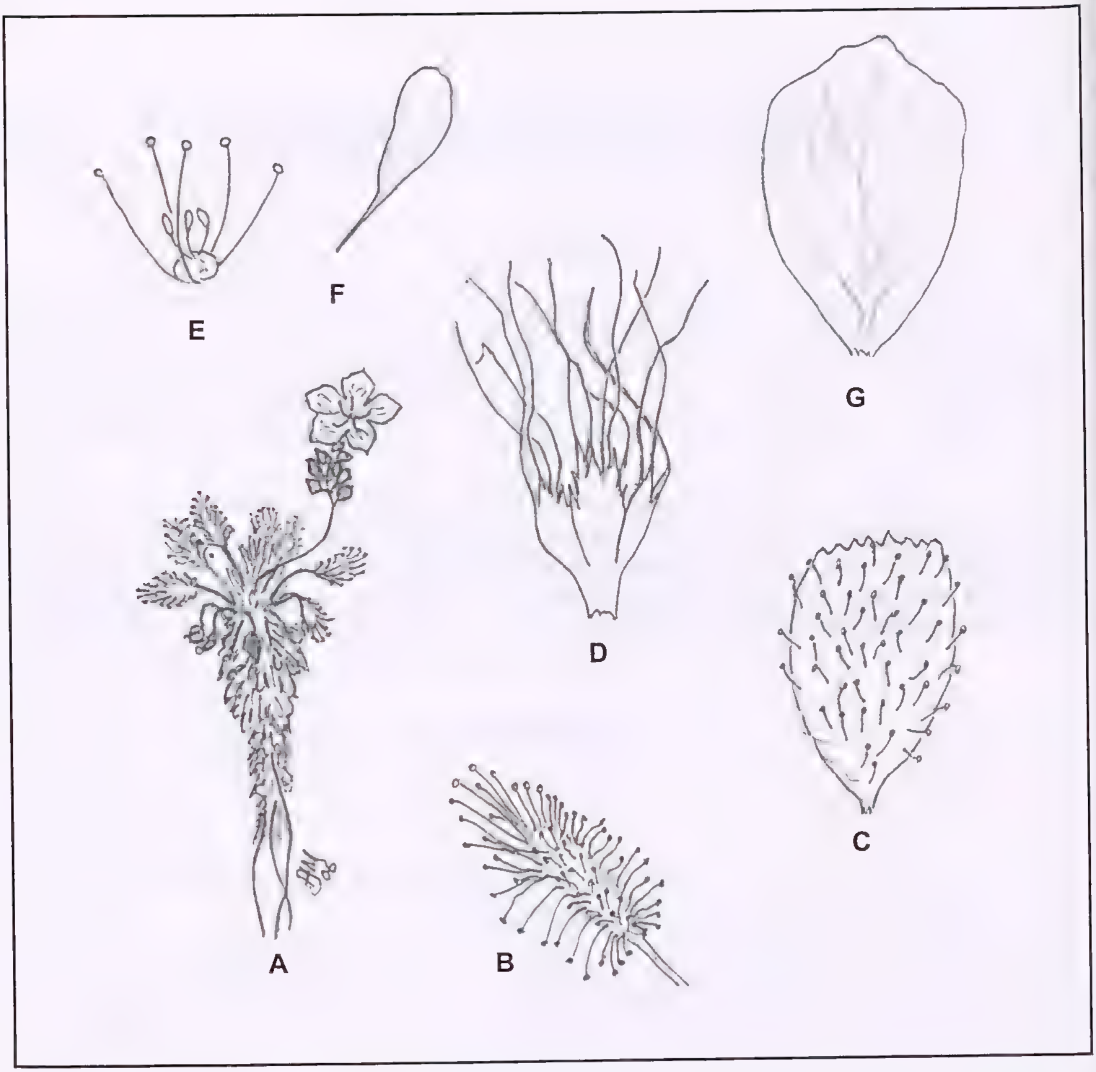

Figure 1. *Drosera gibsonii.* A – a mature flowering plant (×2); B – mature leaf (×10); C – calyx (×20); D – stipule (×10); E – stamens, ovary and styles (×10); F – style and stigma; G – petal (×8).

Distribution. Known only from the one location in Stirling Range National Park. Precise location withheld.

Habitat. In laterite gravel amongst *Allocasuarina* spp. In open heathland on an elevated hill side around 400 m altitude.

Flowering Period. November – December.

Conservation status. Conservation Codes for Western Australian Flora: Priority Two. The only known population is restricted in size but within a National Park.

Etymology. Drosera gibsonii is named in honour of Dr Robert Gibson who has put many dedicated years into the study and classification of *Drosera* species worldwide.

Affinities. *D. gibsonii* belongs in *Drosera* subgenus *Rorella* (DC.) Diels section *Lamprolepis* Planchon, because it has rosetted leaves, prominent stipules, many-flowered scapes and it reproduces asexually by gemmae. *Drosera silvicola* Lowrie & Carlquist is considered here to be the species most similar to *D. gibsonii* due to the shared characteristics of the semi-erect rosette, leaf lamina narrowly elliptical/lanceolate, scapes with short-stalked glands and pink to mauve petals. The two taxa differ in the features presented in the following synoptic key.

Key to species

1. Scapes to 8 cm or more, flowers up to 20, styles red, stigma acuminate, pollen white, sepals apex acute, serrate, petals dark pink with reddish base, semi erect in fruit, old scapes persistent .... **D. silvicola**

1. Scapes to 3 cm, flowers 7–12, styles mauve, stigma translucent white, claviform, pollen yellow, sepals apex premorse, petals pink to mauve, erect in fruit, old scapes non persistent .... **D. gibsonii**

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New species and keys for *Cryptandra* and *Stenanthemum* (Rhamnaceae) in Western Australia

Barabara L. Rye

Western Australian Herbarium, Department of Environment and Conservation
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983

Abstract

Rye, B.L. New species and keys for *Cryptandra* and *Stenanthemum* (Rhamnaceae) in Western Australia. *Nuytsia* 16(2): 325–382 (2007). A generic key for the Rhamnaceae of central and southern Western Australia and keys to Western Australian members of *Cryptandra* Sm. and *Stenanthemum* Reissek are given. Two taxa previously described as varieties are raised to the species level with the new combination *Cryptandra intermedia* (Rye) Rye and the new name *C. multispina* Rye. The new taxa *Cryptandra beverleyensis* Rye, *C. craigiae* Rye, *C. crispula* Rye, *C. dielsii* C.A. Gardner ex Rye, *C. exserta* Rye, *C. imbricata* Rye, *C. inconspicua* Rye, *C. pendula* Rye, *C. micrantha* Rye, *C. stellulata* Rye, *Stenanthemum bremerense* Rye, *S. pumilum* subsp. *majus* Rye, *S. radiatum* Rye and *S. yorkense* Rye are described. Lectotypes are selected for *Cryptandra connata* C.A. Gardner and for the base name of *Cryptandra* sect. *Wichurea* Benth. Some of the newly named taxa are illustrated, distribution maps are given for the south-western species of *Cryptandra* and new taxa in *Stenanthemum*, and the distribution patterns of the south-western genera are discussed in relation to their morphology. There is also a generic description for *Cryptandra*, and new data are given for a few of the previously described taxa in both genera.

Introduction

The family Rhamnaceae is well represented in Western Australian, with over 100 native species in about 16 genera. Publication of descriptions for five new Western Australian species belonging to tribe Pomaderreae has long been delayed because of doubts as to their generic placement. Recent molecular work (Kellermann *et al.* 2005) has indicated that three of these species should be included in *Cryptandra*, another in the recently described genus *Polianthion* K.R. Thiele (Kellermann *et al.* 2006) and the fifth new species in the new genus *Papistylus* Kellermann, Rye & K.R. Thiele. *Papistylus* and another new genus, *Serichonus* K.R. Thiele, are described in the accompanying paper by Kellermann *et al.* (2007). That paper also reduces the circumscription of the genus *Blackallia* C.A. Gardner.

Over the last ten years, new species of Western Australian Rhamnaceae have been discovered by botanical collectors at an average rate of about one per year, mostly as a result of flora surveys of mining leases and other economic sites. Newly discovered species of *Cryptandra* and *Stenanthemum* and other unnamed members of the two genera are described here, with notes updating the previously published information on a few other taxa. There are also distribution maps for the south-western members of the genus *Cryptandra*, a generic description of *Cryptandra*, a key to the Western Australian species of *Cryptandra* and an updated version of the existing key of Rye (2001) to accommodate the new species and subspecies of *Stenanthemum*.

A key to the six genera occurring in the Northern Botanical Province of Western Australia, published in Rye (1997), is here complemented by a key to all genera of Rhamnaceae occurring in the remainder of Western Australia. These two regions have only two genera in common, *Ventilago* Gaertner of the tribe Ventilagineae, which is absent from southern Australia but occurs in both the Kimberley and Pilbara regions, and *Cryptandra* of the tribe Pomaderreae. The six northern genera are varied in terms of the tribes they represent but have only one or two species each in the Northern Botanical Province. In contrast, all but one of the southern species are from the tribe Pomaderreae, which has a pronounced concentration in the south-west. About 90% of the Western Australian species are endemic, and most of these occur in the South West Botanical Province as defined in Beard (1980).

The current paper completes a review of the Western Australian Rhamnaceae, being the last in a series of papers that began with Rye (1995a). Now that generic boundaries have been established for this group, the opportunity is taken here to briefly examine how the generic distribution patterns are related to morphology.

Distribution patterns in relation to morphology

Several correlations have been observed between the geographic distribution of Western Australian members of the Rhamnaceae and their morphology. Before examining these correlations, the main kinds of distribution patterns found among the genera of Pomaderreae are outlined. Maps showing the Western Australian part of the distributions of these genera are available in FloraBase (Western Australian Herbarium 1998–).

Cryptandra and *Stenanthemum* have similar distribution patterns, both being concentrated in the South West Botanical Province and South Western Interzone (SWBP and SWI) of Western Australia, but also with representatives in all other states of Australia and the Northern Territory. Both genera have a single representative in the Pilbara region, but only *Cryptandra* also occurs in the tropical north of Australia and *Stenanthemum* extends further inland.

A second kind of distribution pattern is shown by *Pomaderris* Labill. and *Spyridium* Fenzl, which are much better represented in south-eastern Australia than in Western Australia, especially *Pomaderris* which even extends to New Zealand. In Western Australia, both genera are largely restricted to areas along the south coast, although Basket Bush, *Spyridium globulosum* (Labill.) Benth., extends up the west coast to the Houtman Abrolhos Islands.

The fifth largest genus of the Pomaderreae, *Trymalium* Fenzl, is the only one that is relatively common in the extreme south-west of Western Australia. *Trymalium* is largely restricted to the SWBP and SWI and does not reach the northern and eastern extremities of the SWBP, although it does have one representative in South Australia.

All of the smaller genera of the Pomaderreae are endemic to the south-west of Western Australia except for *Polianthion* K.R. Thiele, which also has a representative from south-eastern Queensland.

Habit

Most members of the Rhamnaceae in the south-west are dwarf to medium-sized shrubs whereas those in the more tropical climates of the far north of the state (Kimberley region) are tall or scrambling shrubs or trees up to 25 m high. Within the genus *Cryptandra*, south-western species are usually 0.1–1.5 m high but the single species from the Kimberley region is up to 2.5 m high. *Alphitonia* Reissek ex Endl. is up to 20 m high in the Kimberley whereas the closely related genus *Granitites* from the south-west has a maximum height of 2 m. Other Kimberley genera have no close relatives in the south.

Among the south-western Rhamnaceae, tree habit is unknown except in the genus *Trymalium*, which has been recorded up to 9 m high in the highest rainfall zones in forested areas of the south-west. *Pomaderris* and *Spyridium* are small to large shrubs that reach a maximum height of about 5 m, while *Stenanthemum* and the small genera reach a maximum height of *c.* 1.5 m or very rarely 2 m.

Spinescence occurs in some of the south-western species of varied genera of Rhamnaceae, with the greatest number of spinescent species in the genus *Cryptandra*. Here, the spines are not related to a climbing habit as in some of the tropical Rhamnaceae. There is some tendency for spinescence to be associated with a rounded shrub habit, often with divaricate interlaced branching. Divaricate interlaced branching is particularly common in the area of the Eremaean bordering the northern part of the South West Botanical Province. In New Zealand this kind of habit is found in the Rhamnaceous genus *Discaria* Hook. (Tomlinson 1978) and it is considered to afford resistance to browsing by large flightless birds. In Australia, perhaps this very stiff compact habit provides some protection from over-grazing by marsupials, or perhaps it provides some physiological advantage in relation to the dryness of the environment.

Two very unusual types of habit within the south-western Rhamnaceae may be of taxonomic significance at the generic level. Adventitious roots occur in *Serichonus* K.R. Thiele, as described in Kellermann *et al.* (2007), and the only other recorded occurrence is in the unrelated species *Cryptandra mutila* (see below). *Stenanthemum sublineare* Rye, a species that is so anomalous in its disc morphology that its placement in *Stenanthemum* has appeared doubtful, seems to be unique in its markedly lignotuberous habit. Its above ground parts are exceptionally small and are commonly exceeded by a large lignotuber situated well below ground level.

Leaf morphology

A variety of modifications that conserve water are found in species of Rhamnaceae from the arid zone. Within each genus, differences between species in leaf morphology are often related to where they occur. One interesting overall trend among the south-western Australian Rhamnaceae is a tendency for leaves with very recurved margins to be more common in the humid areas and conduplicate leaves to be associated more often with drier environments.

Stenanthemum is the only genus to extend right into the centre of Australia. Nearly all *Stenanthemum* species, including all those from the arid zone, have conduplicate leaves with the undersurface very densely hairy; they are able to halve their surface area by closing to completely shield the glabrous or less densely hairy upper surface in times of environmental stress. The few species of *Stenanthemum* that have recurved margins to the leaves and the glabrous upper surface permanently exposed occur in the more humid parts of the generic range in the south-west.

Similarly, the new genus *Papistylus* comprises one species with conduplicate leaves in the northern sandplains of the SWBP and a second species, one with a recurved glabrous upper surface to its leaves, in a high rainfall zone on the Darling Range.

Trymalium has conduplicate hairy leaves on its most inland species, *Trymalium myrtillus* S. Moore, and has broad-leaved species with both surfaces exposed and the upper surface more or less glabrous in the humid extreme south-west. In the intermediate areas there are some species with recurved to revolute leaf margins and the upper surface glabrous.

Juvenile and mature leaves are generally similar in morphology in the south-western Rhamnaceae. However, in the tree species of *Trymalium* known as Karri Hazel, two distinct types of leaves are produced, the juvenile leaves broadly ovate to circular and with scattered long hairs on the upper surface, and the mature leaves narrowly ovate or ovate and more or less glabrous. The large broad lower leaves may maximise the absorption of light for this taxon as it starts out in the undergrowth of forests or in temporary forest clearings.

In *Cryptandra*, the leaves are never conduplicate. Most species have a permanently exposed glabrous upper leaf surface, and the glabrous to densely hairy lower surface is partially to fully hidden by recurved to revolute margins. Some members of the *Cryptandra arbutiflora* complex tend to have both surfaces of the leaves exposed; those taxa that occur in the far south-west have leaves that are glabrous on the undersurface, whereas taxa that occur in the surrounding lower rainfall zones mostly have the lower surface hairy. The few species of *Cryptandra* that extend into the arid zone apparently cope with the increased water stress by having very small leaves and/or the upper leaf surface stellate-hairy, or by retaining very few tightly clustered leaves during dry periods.

While there is some tendency for genera of the Rhamnaceae to be characterised either by conduplicate leaves or leaves with recurved to revolute margins, these leaf characters are generally more useful at the species level as most genera show considerable plasticity in leaf morphology. Stipule characters (as illustrated by Thiele 2007: table 1) are far more reliable indicators of generic differences as they seem little affected by the habitat adaptations that greatly affect leaf morphology.

Descriptions and keys

Holotypes for all the new taxa are lodged at PERTH. All descriptions and all the measurements given in the keys are based on dried material. The words "in outline" are used for descriptions involving two-dimensional terms for leaf shape when the recurved to revolute margins cause the lamina to be thick. For illustrations of some of the main diagnostic characters of the genera, such as the disc characters used in the descriptions and keys below, see Thiele (2007: table 1). Where conservation status is not mentioned in the descriptions below it is because those taxa have numerous populations over wide ranges and are therefore not considered to be at risk. Many of the new taxa have conservation priority; an explanation of the codes used for conservation status is given at the end of each *Nuytsia* volume.

The generic key covers all of Western Australia except for the Northern Botanical Province, also known as the Kimberley Region, for which a key to genera has already been published (Rye 1997). In the species keys distribution data are included to assist with identifications, but the probability that some taxa extend beyond their currently known ranges should be borne in mind.

Key to the genera of Rhamnaceae in central and southern Western Australia

1. Plants glabrous or with simple hairs. Fruit 7–50 mm long, either a long samara or a black 3-locular schizocarp with a thin mealy layer below the exocarp. Seeds uniformly coloured (base not darkened); aril absent or large and deeply coloured, not exceeding seed body

  2. Tree with pendulous branches and almost linear leaves, not spinescent. Anthers without a basal appendage. Fruit a samara, compressed, prominently winged, the seed without an aril. Occurring north of the tropic of Capricorn. (Tribe Ventilagineae).. **Ventilago**

  2. Shrub with spinescent spreading branches and broad leaves. Anthers with a small basal appendage. Mature fruit black, not winged, with a thin mealy layer below the exocarp, the seed with a large, deeply coloured aril. Occurring on granite outcrops in the south-west. (Tribe not established)................. **Granitites**

1. Plants nearly always with stellate hairs, often also with simple hairs. Fruit 1.5–7 mm long, either a brown to dark grey 2–4-locular schizocarp or indehiscent, not winged, with no mealy layer. Seeds nearly always with a darkened base; aril very reduced to larger than the seed body, usually translucent. (Tribe Pomaderreae)

  3. Stipules shortly connate at the base to the outside of the petiole or at least appearing to meet at base on a prominent node, free elsewhere. Leaves with recurved margins often obscuring the undersurface, the petiole glabrous (except in a few northern spp.). Floral tube with a free part extended shortly to far beyond the level of the disc; disc densely stellate-hairy in nearly all species........ **Cryptandra**

  3. Stipules either free and lateral or connate between the petiole and axis. Leaves rarely as above, often conduplicate or with petiole hairy. Floral tube and disc differing from above choice in one or more of the following: floral tube not or scarcely extended above disc; disc absent or glabrous, lining the tube or located near summit of tube

    4. Fresh flowers with petals absent or separated from the anther (although sometimes appearing to enclose the anther in dried material). Style 3-branched at apex. Fruitlets with a membranous or chartaceous basal window though which the seed is shed.

      5. Leaves opposite. Involucral bracts large, enclosing a dense pendulous head-like cluster of flowers. Flowers mostly 4-merous .... **Siegfrieda**

      5. Leaves alternate or clustered. Involucral bracts shorter than flowers and usually inconspicuous at base of pedicels. Flowers 5-merous .... **Pomaderris**

    4. Fresh flowers with petals with a hooded or clasping lamina enclosing the anther, rarely petals absent in *Polianthion* but then style 2-lobed. Style 2- or 3-lobed at apex. Fruitlets either indehiscent or longitudinally dehiscent, without a basal window

      6. Flowers either with anther-clasping petals or with a thick disc adnate to floral tube above the ovary. Fruitlets indehiscent, membranous, chartaceous or crustaceous, if crustaceous then minutely reticulate-pitted to prominently rugose-patterned on the inside or on all surfaces. Aril very reduced, saucer-shaped

7. Flowers sessile or subsessile in dense heads. Petals hooded. Disc adnate to floral tube directly above or separated from ovary. Fruitlets off-white, chartaceous to membranous and without any obvious patterning .... **Spyridium**

7. Flowers pedicellate, usually in a long compound cyme, rarely umbel-like; pedicel (0.3)0.5–3 mm long. Petals anther-clasping. Disc horizontal, usually immediately surrounding ovary; floral tube fully adnate to ovary and disc (except in *T. urceolare*). Fruitlets brown and distinctly patterned on the inside or on all surfaces. .... **Trymalium**

6. Flowers with hooded petals and disc level with ovary or lining tube thinly. Fruitlets longitudinally dehiscent, crustaceous, smooth. Aril medium-sized or large, thick, slightly to prominently 3-lobed

8. Plants inconspicuous, multi-stemmed at ground level from a large below-ground lignotuber; leaves with margins recurved to revolute. Disc thick, surrounding a smooth style............... **Stenanthemum sublineare**

8. Plants small to large shrubs with a single-stemmed or multi-branched base, not lignotuberous; leaves conduplicate in most species, if with margins recurved then disc lining the floral tube or style papillose

9. Disc absent or lining the floral tube. Fruit inferior, more or less subsessile. Seeds usually mottled above their darkened base................. **Stenanthemum**

9. Disc annular (often undulate at first), at junction of free part of floral tube and ovary. Fruit superior to largely inferior, more or less sessile to long-pedicellate. Seeds uniformly coloured above their darkened base

10. Stipules free and well separated, sometimes caducous. Leaves densely stellate-hairy on both surfaces (also with longer simple hairs on one or both surfaces). Floral tube (in flower) spreading, the free part less than 1 mm long and shorter than to scarcely exceeding adnate part. Ovary 2-locular; stigma 2-lobed........................... **Polianthion**

10. Stipules connate at base or for up to half their length (between petiole and axil) and/or overlapping behind the petiole, persistent. Leaves with upper surface glabrous to moderately hairy. Floral tube (in flower) erect, the free part over 1 mm long and much longer than adnate part. Ovary 3-locular; stigma 3-lobed

11. Plants often with spinescent branchlets. Flowers glabrous,with broad base of floral tube bulging slightly downwards below the level of insertion of the tube. Style smooth. Fruit glabrous, superior or largely superior .... **Blackallia**

11. Plants without spinescent branchlets. Flowers hairy, with all of the floral tube rising above the level of insertion of the tube. Style prominently papillose. Fruit hairy, half-inferior or largely inferior

12. Flowers in very lax cymes, long-pedicellate, with pedicel enlarging in fruit 2–3 times. Petal claw and stamen filaments shortly united at base .... **Serichonus**

12. Flowers in head-like clusters, sessile or very shortly pedicellate, the pedicel not enlarging significantly in fruit. Petal claw free from stamen filament ....**Papistylus**

Cryptandra Sm., *Trans. Linn. Soc. London, Bot.* 4: 217 (1798). *Type: Cryptandra ericifolia* = *Cryptandra ericoides* Sm., lectotype *fide* L.K.G. Pfeiffer, Nom. 1: 928 (1873).

Cryptandra Sm. subg. *Cryptandra* [automatically formed by description of subg. *Corisandra* Reissek *in* J.G.C. Lehmann, Pl. Preiss. 2: 285 (1848)] – *Cryptandra* Sm. sect. *Cryptandra* (see Bentham 1863: 438).

Cryptandra subg. *Corisandra* Reissek *in* J.G.C. Lehmann, Pl. Preiss. 2: 289 (1848). *Type: Cryptandra mutila* Nees ex Reissek.

Wichuraea Nees ex Reissek *in* J.G.C. Lehmann, Pl. Preiss. 2: 290 (1848) *nom. illeg. non* M. Roemer, Fam. Nat. Syn. Monogr. 4: 277 (1847) – *Cryptandra* sect. *Wichurea* Benth., Fl. Austral. 1: 443 (1863). *Type: Wichuraea arbutiflora* (Fenzl) Nees ex Reissek, lectotype here selected.

Shrubs dwarf to medium-sized, usually 0.1–1.5 m high, rarely up to 2.5 m high; indumentum usually present on young stems and at least part of the flowers, of simple and/or stellate hairs, with spinescent branchlets occurring in some species. *Stipules* borne on a prominent, usually glabrous base, shortly connate to the outside of petiole or at least meeting there, meeting but free to the inside of petiole, persistent. *Petioles* short or very short, glabrous in most species. *Leaf blades* usually narrow, entire, with recurved to revolute margins slightly to completely concealing the lower surface; upper surface glabrous in most species. *Flowers* usually each subtended by an involucre of 3–16 brown bracts, all or the lower flowers of each branchlet also subtended by a leaf and its stipules, often arranged in a spike-like or head-like cluster on each flowering branchlet. *Floral tube* adnate at base to ovary and with a long or short free tube extending above the ovary summit (but sometimes exceeded by the mature fruit), broad and sometimes bulging at the base. *Sepals* 5. *Petals* 5 (rarely absent), clawed; lamina cupped, enclosing an anther, often minutely papillose on outer surface. *Disc* inserted at the junction of ovary and free floral tube and somewhat to distinctly adnate to ovary, any free part closely appressed to ovary or fruit, undulate to prominently 5-lobed and fully or partially covering ovary in young flower, usually becoming annular with no lobes evident in fruit, stellate-hairy in almost all species. *Ovary* more or less ellipsoid, 1–3-locular (most species 3-locular). *Style* long, glabrous or occasionally with a few stellate hairs at base; stigmatic lobes or surfaces as many as ovary cells. *Fruit* a schizocarp (except in the 1-locular *C. micrantha*), largely inferior to largely superior, more or less ellipsoid or obovoid, indented between the rounded summits of the fruitlets (rarely of a single rounded fruitlet), partially to fully enclosed within the floral tube and bracts; fruitlets (except in *C. micrantha*) crustaceous, longitudinally dehiscent by a suture that extends the full length of the inner surface and over the summit of the fruitlet, with an open basal attachment forming a basal hole when the fruitlet is shed. *Seeds* compressed; body elliptic in outline, with a darkened base or rarely darkened throughout, usually fairly uniformly coloured above base or with a differently coloured border; aril in *C. connata* and *C. imbricata* very large, truncate and orange, but in most species moderately large, succulent, clear-translucent or white to pale ferruginous, with one inner (adaxial) and two lateral lobes, the lobes usually short.

Size and distribution. This is the second largest Australian genus of Rhamnaceae, with 55–60 or more species. It occurs mainly in southern mainland Australia, also with representatives in Tasmania, north-eastern Australia and the far north of the mainland, and with a single species from the Pilbara region, *C. monticola* Rye & Trudgen (see Rye & Trudgen 1995: fig. 1), but is absent from much of the arid zone. Currently 35 species are recognised in Western Australia, nearly all of them endemic, but *Cryptandra aridicola* extends slightly into South Australia and *C. myriantha* also occurs in South Australia and Victoria (J. Kellerman pers. comm.). *Cryptandra intratropica* W. Fitzg. is only known from the Kimberley region, but occurs so close to the border of the Northern Territory (Rye 1997: fig. 2C) that it may well extend outside Western Australia.

Lectotypification. A lectotype has already been chosen for *Cryptandra* but not for the synonymous generic name *Wichuraea* described by Reissek (1848). *Wichuraea* is illegitimate because this name had been used in the previous year for a genus of plants in a different family. Bentham (1863) legitimised the name when he reduced the group to a section of *Cryptandra* with a different spelling. Reissek (1848) listed two taxa, *Wichuraea arbutiflora* and *W. tubulosa*, now considered to be conspecific, being treated as two varieties of *Cryptandra arbutiflora*. The first of these, *W. arbutiflora*, is selected here as the lectotype for *Wichuraea*. This synonym of *Cryptandra arbutiflora* is therefore eastablished as the type species of *Cryptandra* sect. *Wichurea*.

Notes. Unlike most other genera of tribe Pomaderreae, *Cryptandra* usually does not have its flowers borne in cymose arrangements. Instead each flower is usually subtended by an involucre of up to 16 bracts. Two other unique characters in *Cryptandra* are the stipule type, as described above and in the generic key, and the presence of stellate hairs on the disc. All these characters are illustrated in Thiele (2007: table 1).

Three subgenera or sections have been recognised for *Cryptandra*, reflecting some of the great variation that occurs within this large genus, and several other species groups worthy of formal recognition (Thiele pers. comm.) have been suggested. A subgeneric classification would be useful, but more data on the genus throughout Australia are needed before this could be achieved. Ideally, molecular sampling of all or a large proportion of the species should be undertaken before any attempt is made to produce a new classification.

Most species of *Cryptandra* have sessile or subsessile flowers. Subgenus *Corisandra* was separated to accommodate a single species with pedicellate flowers and would, if still recognised, now contain three species. These three species include *Cryptandra pungens* Steud., which Reissek (1848) retained in the typical subgenus of *Cryptandra* [as subg. *Eucryptandra nom. illeg.*].

The last infrageneric group, Bentham's section *Wichurea*, has the lectotype *Cryptandra arbutiflora* as discussed above and, if it were to be reinstated, would need to include all of the *C. arbutiflora* complex. This group is somewhat atypical in having the disc largely free from the ovary and very prominently lobed.

Three of the new species described below are oddities in one way or another, as discussed under the individual species, and inclusion of them within *Cryptandra* has resulted in an expansion of the characters accepted in the generic description above. For example, the 1-locular character state has been added for the ovary and fruit.

Key to Western Australian species and infraspecific taxa of *Cryptandra*

1. Flowers shortly to obviously pedicellate, in an umbel-like cluster; pedicel 0.4–3 mm long, surrounded by 2–4 bracts

  2. Leaves hairy on both surfaces of the blade and on petiole. Flowers with a hairy floral tube and 2-lobed stigma. (Kimberley region) .... **C. intratropica**

  2. Leaves glabrous on upper surface of blade and on petiole. Flowers differing from above choice in either being glabrous or having a 3-lobed stigma or both

    3. Floral tube glabrous. Ovary and fruit 2- or less commonly 3-locular. Occurring mostly on coastal limestone. (Dirk Hartog Is. to Rockingham)........ **19. C. mutila**

3. Floral tube hairy. Ovary and fruit 3-locular. Occurring mostly inland

4. Branchlets not spinescent. Pedicels short and tending to be hidden. Disc glabrous. (Dumbleyung area to Fitzgerald River)............ **16. C. inconspicua**

4. Branchlets spinescent. Pedicels long and obvious. Disc hairy. (Geraldton area to Cape Arid National Park)... **C. pungens**

1. Flowers sessile or subsessile (pedicel less than 0.3 mm long), solitary or in a head-like cluster, with the base of the floral tube enclosed by (3)5–16 imbricate bracts

5. Stigma entire (with a single stigmatic surface) or 2-lobed. Fruit 1- or 2-locular

6. Sepals 0.6–0.8 mm long. Stigma entire. Ovary 1-locular. Fruit apparently indehiscent, with a flexible wall. (Canna to Wongan Hills to Boorabbin)...**17. C. micrantha**

6. Sepals 0.9–1.3 mm long. Stigma with 2 small but distinct lobes. Ovary 2-locular. Fruit a schizocarp, crustaceous.

7. Flowers with a short and fairly uniform indumentum on outside of floral tube and sepals. Fruit rather densely stellate-hairy on inferior part. (Wallaroo to Queen Victoria Spring Nature Reserve to Clyde Hill)..........**C. distigma**

7. Flowers with long dense indumentum on sepals and much less hairy or glabrous below. Fruit glabrous or with a few stellate hairs on inferior part. (Cooloomia Nature Reserve to Fitzgerald River to Boorabbin to Truslove)..**C. spyridioides**

5. Stigma 3-lobed or with 3 lateral stigmatic surfaces. Fruit 3-locular

8. Disc surrounding and spreading horizontally away from base of ovary in young flower, adnate or appressed to base of floral tube. Fruit prominently beaked, 6–7 mm long including apical beak. Seed uniformly coloured; aril very large, truncate, brightly coloured

9. Bracts largely glabrous outside. Flowers glabrous outside except for the apex of the sepals. (Mount Magnet area to Kalgoorlie) .... **11. C. connata**

9. Bracts hairy outside. Flowers hairy outside. (Toolonga Nature Reserve to Lake Moore)..**12. C. imbricata**

8. Disc partially to fully obscuring ovary in young flower, adnate or appressed to ovary. Fruit not beaked, 2–5 mm long; apex rounded and indented. Seed darkened at base; aril small to moderately large, usually distinctly 3-lobed, pale or colourless

10. Young stems with a matted indumentum of long very fine hairs, the individual hairs too tangled for their type (whether simple or stellate) to be readily determined

11. Floral tube (in flower) 1.5–2 mm long, enclosed in *c.* 3 bracts (not including the involucral bracts surrounding the flower head); free part of tube 0.8–1 mm long. Style glabrous, papillose. (Manmanning to Varley) ... **4. C. dielsii**

11. Floral tube (in flower) either less than 1.2 mm long or enclosed in an involucre of 8–16 bracts. Style glabrous or hairy, not papillose

12. Bracts 3–8 per flower. Floral tube (in flower) 0.7–1.1 mm long; free part of tube 0.4–0.7 mm long

13. Leaves mostly appearing sessile, the petiole 0.1–0.3 mm long and usually hidden within the stipule sheath. Sepals hairy throughout or towards apex, usually with a tuft of hairs protruding from the apex

14. Flowers with largest hairs 0.4–0.8 mm long, the upper floral tube subglabrous in contrast with the very densely hairy sepals. (Tammin to Lake King area)..... **C. polyclada** subsp. **polyclada**

14. Flowers with largest hairs 0.2–0.3 mm long, the upper floral tube and sepals both densely hairy. (Boorabbin area).. **C. polyclada** subsp. **aequabilis**

13. Leaves distinctly but shortly petiolate, the petiole 0.3–0.6 mm long and exserted from the stipule sheath. Sepals glabrous throughout or with a sparse indumentum of simple appressed hairs towards the apex. (Mt Day to Lake Cowan to Ravensthorpe)..**C. graniticola**

12. Bracts (8)9–16 per flower. Floral tube (in flower) 1.5–3.5 mm long; free part of tube 1–3 mm long

15. Sepals with a protruding apical tuft of hairs 1 mm or more long and at least 4 times longer than indumentum on remainder of sepal. Ovary and basal part of style with hairs *c.* 1 mm long. (Woodanilling to Frank Hann National Park).................................... **9. C. leucopogon**

15. Sepals with hairs of uniform length or the apical hairs up to twice as long as indumentum on remainder of sepal, the apical hairs 0.1–0.5 mm long (except in *C. crispula*). Ovary and base of style with hairs 0.2–0.5 mm long

16. Leaves with apical point fairly erect. Free part of floral tube exserted well beyond involucre of bracts in flower (Hatter Hill to Norseman area)... **15. C. exserta**

16. Leaves with apical point recurved. Free part of floral tube usually hidden within involucre of bracts in flower

17. Petals with a claw 0.5–0.8 mm long. Style 3.5–5 mm long. Occurring well inland, in Eremaean and eastern part of Interzone. (Anketell Station to Cosmo Newberry to Fraser Range, also SA) .... **6. C. aridicola**

17. Petals with a claw 0.2–0.4 mm long. Style 0.8–3.5 mm long, if 3–3.5 mm long then restricted to South West Botanical Province and western part of Interzone

18. Leaves 0.8–2 mm long, rarely more. Sepals hairy throughout, sometimes with longer hairs concentrated towards apex but not forming well defined tufts and not exceeding 1 mm long

19. Sepals 2.7–3.7 mm long. Floral tube (in flower) 2.3–3.5 mm long, enclosed in 12–14 bracts; free part of tube 1.8–2.8 mm long. Style 2.5–3.5 mm long. (Manmanning to Dumbleyung to Ravensthorpe Range).........**10a. C. minutifolia** subsp. **minutifolia**

19. Sepals 1.5–2.5 mm long. Floral tube (in flower) 1.5–2.3 mm long, enclosed in (8)9–12 bracts; free part of tube 1–1.5 mm long. Style 0.8–1.8(2.5) mm long. (Kulin to Barker Lake to Stirling Range area to Lort River area) .... **10b. C. minutifolia** subsp. **brevistyla**

18. Leaves 2.5–4 mm long. Sepals usually either largely glabrous or with a well developed terminal tuft of hairs at least 1 mm long

20. Sepals often partially glabrous, with all hairs less than 0.5 mm long. (Goomalling to Beaufort River)........................**7. C. beverleyensis**

20. Sepals very densely hairy, the apical hairs 1–1.5 mm long. (Coolgardie area to east of Norseman)...................................**8. C. crispula**

10. Young stems glabrous, papillose or with simple and/or stellate hairs distinguishable, the indumentum not matted but often dense

21. Free part of floral tube 0.3–0.7(0.8) mm long in flower (enlarging in fruit)

22. Flowers hairy outside on floral tube and sepals

23. Branchlets spinescent except on young plants. Free part of floral tube and sepals with simple but no stellate hairs. (Hopetoun area).........**13. C. craigiae**

23. Branchlets not spinescent. Free part of floral tube and sepals densely covered by a mixture of stellate and simple hairs

24. Petals usually absent, if present then readily shed and with the lamina reduced so that the claw tends to be as long as the lamina. (Nerren Nerren Station to Barker Lake)...............**C. apetala** var. **apetala**

24. Petals present, fully enclosing an anther, the claw much shorter than the lamina

25. Young stems minutely stellate-hairy (in *C. apetala* sometimes also with larger simple hairs 0.2–0.4 mm long). Leaves minutely stellate- hairy or glabrous

26. Leaves with a fairly erect apex. Petals with a claw 0.2–0.4 mm long. (Wyalkatchem to Lake King) .... **C. apetala** var. **anomala**

26. Leaves with a prominently recurved apex. Petals with a claw 0.1–0.15 mm long. (Boorabbin area to Fitzgerald River National Park to Cocklebiddy)...............................**C. recurva**

25. Young stems with appressed to spreading simple hairs 0.3–1 mm long. Leaves glabrous, with minute broad protrusions or with simple hairs up to 0.8 mm long. (Mingenew area to near Albany to Cocklebiddy).....................................**C. nutans**

22. Flowers glabrous outside throughout or in part (at least glabrous on free part of floral tube)

27. Sepals about as long as free part of floral tube, recurved

28. Spinescent branchlets absent or long (10–20 mm), with at least one node. Young stems usually hairy, with dark bark peeling in narrow strips and patches. (Dongara to Perth)..................**C. scoparia**

28. Spinescent branchlets numerous, *c.* 6 mm long, nodeless or with only one node. Stems glabrous or glabrescent, with pale bark peeling in large strips. (Zuytdorp National Park to Marchagee)...... **18. C. multispina**

27. Sepals (in flower) distinctly longer (usually two to four times) than free part of floral tube, usually spreading

29. Sepals hairy throughout or in distal half; simple hairs present. (Kalbarri area to Albany area to Cape Arid National Park, also South Australia and Victoria).. **C. myriantha**

29. Sepals glabrous or with a few scattered stellate hairs

30. Sepals at least four times as long as free part of floral tube. Fruit with coarse hairs over 0.5 mm long on summit. (Kalbarri area) .... **C. glabriflora**

30. Sepals about twice as long as free part of floral tube. Fruit glabrous on superior part, except for the stellate-hairy disc. (Lake Muir area) .... **1c. C. arbutiflora** var. **pygmaea**

21. Free part of floral tube (0.9)1–3.5 mm long in flower (enlarging in fruit)

31. Floral tube glabrous

32. Flowers in dense clusters. Sepals densely hairy towards apex. (Denmark area) .... **C. congesta**

32. Flowers loosely arranged in leafy spike-like inflorescences. Sepals glabrous

33. Leaves densely stellate-hairy on lower surface, sometimes becoming glabrous with age. Peduncles sparsely to densely stellate-hairy

34. Young stems with scattered stellate hairs less than 0.1 mm long. (Morawa to Gingin to Beverley) .... **5. C. stellulata**

34. Young stems with a dense or moderately dense indumentum of stellate hairs 0.2–0.3 mm long or with mainly simple hairs

35. Young stems with hairs mostly stellate. Floral tube 4–4.5 mm long. Fruit largely inferior. (Allanooka area, SE of Geraldton).......... **4. C. pendula**

35. Young stems with hairs mostly simple. Floral tube 1.7–3 mm long. Fruit *c.* half-inferior to largely superior. (N of Gairdner Range to Gingin and Stirling Range to Ravensthorpe area)......... **2. C. intermedia**

33. Young leaves glabrous on lower surface or with simple hairs along the midvein. Peduncles glabrous

36. Stem hairs recurved. Floral tube 1.2–1.8(2.3) mm long. Fruit usually with scattered large stellate hairs on superior part. (Kalbarri to Chapman River)............ **1b. C. arbutiflora** var. **borealis**

36. Stem hairs usually antrorse or patent. Floral tube usually either less than 1.5 mm long or 2.5–4.5 mm long. Fruit nearly always glabrous

37. Dwarf shrubs 0.05–0.25 m high. Floral tube *c.* 1 mm long. (Lake Muir area).......................... **1c. C. arbutiflora** var. **pygmaea**

37. Shrubs 0.1–1 m high. Floral tube 1.2–4.5 mm long

38. Ovary largely superior in fruit, within a broad floral tube. Occurring inland of var. *tubulosa* on granite or laterite. (Gillingarra to Mount Barker and Jerramungup areas) .... **1a. C. arbutiflora** var. **arbutiflora**

38. Ovary about half inferior in fruit, within a slender floral tube. Occurring on the west coast on limestone and in the south on granite. (Perth to Kent River)............................. **1d. C. arbutiflora** var. **tubulosa**

31. Floral tube hairy

39. Leaves silvery pale green, densely hairy on blade and petiole. Occurring in the Pilbara region. (Hamersley Range to near Newman)..... **C. monticola**

39. Leaves green, glabrous or subglabrous on upper surface of blade and petiole. Distribution south-western

40. Stipules prominent, 4–6.5 mm long. Leaves with a prominent recurved apical point 0.2–0.5 mm long. Floral tube (in flower) 3–3.5 mm long. (Middle Ironcap to Hatter Hill).. **C. intonsa**

40. Stipules small, 0.7–1.4 mm long. Leaves with a minute mucro or obtuse. Floral tube (in flower) 1.4–2.5 mm long

  41. Free part of floral tube 1.5–2 mm long in flower. Style 2–2.5 mm long. (East Yuna Reserve to Canna).. **3. C. nola**

  41. Free part of floral tube 0.9–1.4 mm long in flower. Style 0.7–1.3 mm long. (Wialki area to Cape Riche to Gibson area) .... **C. wilsonii**

The *Cryptandra arbutiflora* complex

Members of the *Cryptandra arbutiflora* complex extend from Kalbarri south-east to Hopetoun and to the extreme south-west corner of Western Australia, occurring in rocky locations with laterite, granite or limestone. This extremely variable group was previously considered to consist of two species, *C. nola* Rye and the polymorphic *C. arbutiflora*, for which five variants had been formally named as varieties. Two newly discovered species are named here as *Cryptandra pendula* and *C. stellulata*, bringing the total number of taxa recognised formally to eight. They mostly exhibit a pattern of geographic replacement but there are a few areas of overlap.

One of the varieties of *C. arbutiflora* is raised to the species level to become *C. intermedia*, differing from the four remaining varieties of *C. arbutiflora* in having stellate hairs on the stems, peduncles and undersurface of the leaves. Possibly, other varieties of *C. arbutiflora* should be recognised at least at the subspecific level but considerable variation within most of the varieties and the presence of intermediates has confused the taxonomy. There are also two new poorly known variants from the far south-east of the range of the *C. arbutiflora* complex that are now included within *C. intermedia*. One of these had previously been given the informal name *Cryptandra* sp. Ravensthorpe (*G.F. Craig* 6309).

Two members of the complex, *Cryptandra arbutiflora* var. *borealis* and *C. nola*, were included in a molecular analysis of a diverse selection of taxa from the tribe Pomaderreae (Kellermann *et al.* 2005). They formed a sub-clade nested well within the overall *Cryptandra* clade.

In addition to the descriptions of the newly recognised species in the complex, notes are included here for each of the varieties of *C. arbutiflora* to update the information published previously in Rye (1995b) and selected specimens, mainly from areas of range extension, are cited.

1. Cryptandra arbutiflora Fenzl *in* S.F.L. Endlicher, E. Fenzl, G. Bentham & H.W. Schott, Enum. Pl. Hueg. 26–27 (1837). – *Wichurea arbutiflora* (Fenzl) Nees ex Reissek *in* J.G.C. Lehmann, Pl. Preiss. 2: 2: 290 (1848). *Type:* Swan River [Western Australia, November–December 1833], *C.A. von Huegel* (*holo:* W).

Notes. This commonly collected species has two main areas of occurrence, one in the north separated by a large disjunction of over 300 km from a much larger southern area of occurrence, with three varieties recognised in the south and a fourth variety in the north. All of the varieties of *Cryptandra arbutiflora* have simple hairs but no stellate hairs on their young stems and are glabrous on the peduncles. They are also glabrous on the undersurface of the leaves or very rarely have a few simple hairs on the midrib.

1a. **Cryptandra arbutiflora** Fenzl var. **arbutiflora**

Young stems with a varied indumentum of coarse or fine, patent or spreading, straight or curved, invariably simple hairs, often with a mixture of minute and long hairs, the longer patent hairs 0.2–0.5 mm long. *Petioles* 0.5–1 mm long. *Leaf blades* 2.5–9 × 0.8–2.5 mm; lower surface glabrous, rarely with a few short simple hairs along midvein; upper surface usually glabrous, rarely with short or long simple patent hairs. *Peduncles* glabrous. *Floral tube* 2.5–5 mm long (not or scarcely enlarging in fruit); adnate part of tube absent or very short and hidden below basal bulge of free part so not contributing to the overall length of the tube; free part 2.5–5 mm long. *Sepals* 1.2–1.5 mm long. *Style* (1.5)2–4 mm long, usually reaching anthers or exserted, rarely shorter and included; stigmatic lobes usually scarcely extending laterally from apical part of style. *Fruit* 3/4 to fully superior, 2.5–2.8 mm long, superior part nearly always glabrous. *Seeds* 2–2.2 mm long; body 1.5–1.6 × 0.9–1.2 mm, uniformly orange-brown above a very dark base or with a differently coloured border; aril 0.8–0.9 mm long, often whitish, 3-lobed.

Selected specimens examined. WESTERN AUSTRALIA: 6.7 miles [10.8 km] E of Carani, 30 Aug. 1971, *T.E.H. Aplin* 4883 (PERTH); 17 km WSW of Calingiri, Rica Erickson Reserve, 31°09'S, 116°18'E, 16 Sep. 2004, *R.K. Brummitt, A.S. George & E.G.H. Oliver* 21308 A (PERTH); Harper Rd–Balgarup Rd, 25 km SSW of Kojonup, 34°03'S, 117°05'E, 24 Oct. 1997 *C.M. Lewis* 306 (PERTH)

Selected atypical specimens examined (possible intermediates with var. *pygmaea*). WESTERN AUSTRALIA: Carbarup Rd near railway, Mount Barker, 34°38'S, 117°40'E, 10 Sep. 1983, *E.J. Croxford* 2553 (ALB, PERTH); riverside, off Woogenellup Rd, W of Kamballup, 34°33'S, 117°54'E, 12 Aug. 1997, *E.J. Croxford* 7791 (ALB, PERTH).

Distribution. Extends from Gillingarra south to Collie and south-east to Mount Barker and the Jerramungup area. (Figure 1B)

Notes. This variety overlaps considerably in its distribution with *Cryptandra intermedia* (Figure 1C), from which it is distinguished by its complete lack of stellate hairs on its young stems (all hairs being simple), the glabrous or almost glabrous undersurface of its leaves, and its glabrous peduncles. It usually also has longer styles. In the south-west, there are possible intermediates between *Cryptandra arbutiflora* var. *arbutiflora* and var. *pygmaea* (cited above) that are currently housed under var. *arbutiflora* but have yet to be examined in fruit. There may also be intermediates between var. *arbutiflora* and var. *tubulosa*. The paucity of fruiting material is a problem in distinguishing var. *arbutiflora* from var. *tubulosa* and var. *pygmaea* since the main distinguishing feature of var. *arbutiflora* is its largely to fully superior fruit, a character that is not available in flowering material.

Stem indumentum is particularly variable in *Cryptandra arbutiflora* var. *arbutiflora*. Many specimens have a fairly uniform indumentum of antrorsely curved hairs and a few specimens are similar but have retrorsely curved hairs; in both cases the leaves are glabrous on the upper surface and the stem hairs are often coarse. Many other specimens have patent or spreading straight hairs, often with a mixture of long and short simple hairs; in these specimens the leaves often also have simple hairs on their upper surface. However, there is no perfect separation of the specimens with these two main types of indumentum, which seem to show no correlation with other morphological characters.

The lengths of the floral tube and style are quite variable in *Cryptandra arbutiflora* var. *arbutiflora*, and one odd specimen was observed to have very short included styles *c.* 1.5 mm long.

1b. Cryptandra arbutiflora var. **borealis** Rye, *Nuytsia* 10: 260 (1995). *Type:* 17 km from Northampton on Port Gregory road, Western Australia, 8 August 1994, *S.J. Patrick* 1966 (*holo:* PERTH 04159810; *iso:* CANB).

Illustration. Rye (1995b: fig. 2A–C).

Young stems with coarse recurved or retrorse tubercles or minute simple hairs up to 0.1 mm long. *Petioles* 0.5–1.2 mm long. *Leaf blades* 4–14 × 0.6–2.5 mm; lower surface glabrous; upper surface glabrous. *Peduncles* glabrous. *Floral tube* 1.2–2.3 mm long (enlarging to 2–3 mm in fruit); adnate part of tube 0.2–0.4 mm long; free part 1–2 mm long. *Sepals* 1–1.8 mm long. *Style* 1.7–2.8 mm long, usually exserted; stigmatic lobes spreading, 0.1–0.2 mm long. *Fruit* 2/5 to half-inferior, 2.2–2.8 mm long, superior part often with scattered large stellate hairs. *Seeds* 1.7–2.1 mm long; body 1.3–1.6 × 0.7–1.2 mm, uniformly orange-brown above a very dark base; aril 0.6–0.8 mm long, ferruginous, 3-lobed.

Selected specimens examined. WESTERN AUSTRALIA: at creek crossing on Scott Rd, 3.15 km N of Chapman East Rd, 28°38'S, 114°48'E, 20 Aug. 2003, *B.L. Rye* 238062 *& M.E. Trudgen* (PERTH); SE access Fairfax Drive, E bank of river, Chapman River Regional Park, 13 July 2001, *S. Vigilante* 302 (PERTH).

Distribution. Extends from Kalbarri south to Chapman River (Figure 1B).

Notes. This taxon occurs in the far north-west of the range of the *Cryptandra arbutiflora* complex. New collections of *C. arbutiflora* var. *borealis* have extended its range southwards somewhat and its range is surrounded to the south and east by those of *C. nola* and *C. pendula.*

Cryptandra arbutiflora var. *borealis* is less variable in its indumentum than the other varieties of *C. arbutiflora* and can generally be distinguished from them by the retrorse tubercles or minute hairs on its young stems. Other variants usually have longer hairs, which are usually patent or curved in an antrorse direction. A few specimens of var. *arbutiflora* are like var. *borealis* in having retrorse hairs but their hairs are longer than those of var. *borealis*. Stellate hairs are usually present on the ovary in var. *borealis* but are nearly always absent in the other varieties.

1c. Cryptandra arbutiflora var. **pygmaea** Rye, *Nuytsia* 10: 262 (1995). *Type:* Muir Highway, Western Australia, 16 November 1990, *A.R. Annels* 1291 (*holo:* PERTH 03128830).

Illustration. Rye (1995b: fig. 2I–M).

Young stems with a varied indumentum of coarse patent or spreading, straight or curved simple hairs up to 0.3 mm long. *Petioles* 0.4–0.8 mm long. *Leaf blades* 3–6 × 0.6–2 mm; lower surface glabrous; upper surface glabrous. *Peduncles* glabrous. *Floral tube* 1–1.5 mm long (enlarging to 1.5–2 mm in fruit); adnate part of tube *c.* 0.3 mm long. *Sepals* 1.4–1.5 mm long. *Style* 1.4–2 mm long, usually exserted; stigmatic lobes usually scarcely extending laterally from apical part of style. *Fruit* 1/5–1/3-inferior, 2–2.5 mm long, superior part glabrous. *Seeds* 1.7–1.8 mm long; body *c.* 1.3 × 0.7–0.8 mm, uniformly orange-brown above the dark base or with the border differently coloured; aril *c.* 0.6 mm long, whitish, 3-lobed.

Selected specimens examined. WESTERN AUSTRALIA [precise localities withheld]: Muir Highway, 15 Nov. 1990, *A.R. Annels* 1281 (PERTH); S of Rocky Gully, 9 Sep. 1995, *A.R. Annels* 5424 & *R.W. Hearn* (PERTH); Tonebridge, 5 Sep. 1995, *R.J. Cranfield* 10292 (PERTH); Galamup Nature Reserve, 23 Oct. 1997, *G.J. Keighery & N. Gibson* 2376 (PERTH).

Distribution. Extends from near Tonebridge south-west to near Nyamup and south-east to near Rocky Gully (Figure 1B).

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. This variety is recorded from at least six populations (two in nature reserves) over a range of *c.* 70 km, although attempts to relocate the oldest population near Nyamup have been unsuccessful; without that locality the known range is only *c.* 40 km.

Notes. Two of the new collections (*A.R. Annels* 1281 and *G.J. Keighery & N. Gibson* 2376) have mature seeds. One character previously noted as possibly aiding separation of this taxon from other varieties was the separation of the stellate-hairy disc from the adnate part of the floral tube in fruit; this is now known to occur sometimes in the other varieties and so is not considered to be an important character. Possible intermediate specimens between var. *pygmaea* and var. *arbutiflora* are listed under var. *arbutiflora*.

1d. Cryptandra arbutiflora var. **tubulosa** (Fenzl) Benth., Fl. Austral. 1, 444 (1863). – *Cryptandra tubulosa* Fenzl *in* S.F.L. Endlicher, E. Fenzl, G. Bentham & H.W. Schott, Enum. Pl. Hueg. 26 (1837). *Type:* "King George Sound" [probably actually collected at or near Perth, Western Australia, November–December 1833], *C.A. von Huegel* (*holo:* W).

For other synonyms see Rye (1995b: 263).

Illustration. Rye (1995b: fig. 2N–Q).

Young stems with an indumentum of coarse or fine, patent or spreading or antrorsely curved simple hairs up to 0.4 mm long, often with medium-sized curved hairs not varying much in length, sometimes with a mixture of minute and long patent hairs. *Petioles* 0.5–0.8 mm long. *Leaf blades* 2.5–7 × 0.8–1.5 mm; lower surface glabrous; upper surface glabrous or sometimes with simple patent hairs. *Peduncles* glabrous. *Floral tube* 3–4.5 mm long (not enlarging significantly in fruit); adnate part of tube less than 1 mm long. *Sepals* 1.2–1.5 mm long. *Style c.* 3.5 mm long, usually exserted; stigmatic lobes usually scarcely extending laterally from apical part of style. *Fruit c.* half-inferior, *c.* 2 mm long, superior part glabrous. *Seeds c.* 1.5 mm long; body *c.* 1.2 × 0.7 mm, medium brown with margin somewhat different from centre above a dark base; aril 0.5–0.6 mm long, whitish, 3-lobed.

Selected specimens examined. WESTERN AUSTRALIA: Plot 5093, 11.5 km S of Rocky Gully, on Kent River, 20 Sep. 1993, *A.R. Annels* 3689 (PERTH); Kemerton Industrial Estate, S of Marriott Rd, 9 km SE of Binningup, 33°13'S, 115°44'E, 28 Sep. 1993, *B.J. Keighery & N. Gibson* 388 (PERTH); Donnelly Mill Rd, Yornup, 34°05'S, 116°04'E, 19 Aug. 1997, *S. May* 57 (PERTH).

Distribution. Recent collections of the taxon in the far south of the state are from granite habitats extending from the far south-west coast inland to near Bridgetown and extending east to Kent River. (Figure 1C)

Notes. Huegel's collections from the Swan River Colony were made in the vicinity of Perth between 17 November and 19 December 1833, and at King George Sound in early January 1834 (Endlicher *et al.* 1837). Some specimens labelled as coming from King George Sound must have been collected earlier from Perth because they are of taxa known only from the former region, for example *Astartea affinis* (Schauer) Rye (Rye 2006). *Cryptandra arbutiflora* var. *tubulosa* appears to be another example of this, as it used to occur at multiple locations on limestone on the coast and around the Swan River estuary, Perth, but is not known from King George Sound.

Fruit and seed measurements were taken from *N. Casson & D. Bright* SC13.2. More good fruiting material is needed for this variety. See also notes under var. *arbutiflora*.

2. **Cryptandra intermedia** (Rye) Rye, *comb. nov.*

Cryptandra arbutiflora var. *intermedia* Rye, *Nuytsia* 10: 260–262 (1995). *Type:* 2 km south-west of Jurien Bay turnoff from Brand Highway, 3.7 km west along track opposite Marchagee track, Western Australia, 2 July 1992, *R.J. Cranfield & P. Spencer* 8283 (*holo:* PERTH 02847515; *iso:* CANB).

Illustration. Rye (1995b: fig. 2D–H).

Shrubs usually 0.2–0.7 m high, commonly with spinescent branchlets 7–20 mm long. *Stipules* 0.8–1.4 mm long, attenuate to acuminate, glabrous. *Young stems* with a varied indumentum of coarse or fine patent or spreading hairs up to 0.3 mm long, often with a mixture of small stellate hairs and longer simple hairs or with both short and long simple hairs, sometimes mainly with hairs of only one kind; simple hairs either straight and patent or curved and antrorse; stellate hairs always present in at least some positions but less common than the simple hairs and often absent from large areas of the stems. *Petioles* 0.4–1.2 mm long, well exserted from stipules. *Leaf blades* more or less elliptic to linear in outline, 3–9 × 0.6–2 mm, with a recurved or erect mucro up to 0.3 mm long; lower surface usually largely concealed by the recurved to revolute margins, densely stellate-hairy, sometimes becoming glabrous with age; upper surface glabrous, tuberculate or with coarse or fine simple patent hairs. *Peduncles* densely stellate-hairy or rarely sparsely stellate-hairy. *Bracts c.* 8, broadly ovate to oblong-elliptic, the inner ones *c.* 1 mm long, obtuse, becoming torn. *Flowers* usually 2–10 per branchlet in a spike-like arrangement, white. *Floral tube* 1.5–3 mm long (enlarging to 2–4 mm in fruit); adnate part of tube *c.* 0.4 mm long; free part 1.2–2.8 mm long. *Sepals* 1.2–1.7 mm long, glabrous. *Petals c.* 0.8 mm long; claw 0.1–0.2 mm long. *Disc* with stellate hairs *c.* 0.2 mm long. *Ovary* 3-locular; summit usually with few stellate hairs *c.* 0.3 mm long, sometimes more densely stellate-hairy or glabrous. *Style* usually 1–2.4 mm long, below or reaching the level of the anthers, rarely up to 3.5 mm long and well exserted; stigmatic lobes usually scarcely extending laterally from apical part of style. *Fruit* 1/5- to half-inferior, 2.2–2.6 mm long, superior part stellate-hairy or sometimes glabrous. *Seeds* 1.5–2.1 mm long; body 1.2–1.5 × 0.6–0.8 mm, uniformly coloured above the dark base or with a differently coloured border; aril 0.5–0.6 mm long, white or pale-ferruginous, 3-lobed.

Selected specimens examined. WESTERN AUSTRALIA: 2.3 km S of South Coast Highway on Hopetoun–Ravensthorpe road opposite entrance of old copper smelter, 8 Feb. 2005, *G.F. Craig* 6309 (PERTH); at corner of road (Formby) to Gnowangerup and Chester Pass Rd, Mt Trio, Stirling Range, 7 July 1985, *E.J. Croxford* 4281 (PERTH); Northam, Oct. 1900, *Gregory* (PERTH); York, 3 Sep. 1905, *O.H. Sargent* 346 (PERTH).

Distribution. Extends from north of Gairdner Range south to Gingin and south-east to the Beverley area, apparently also occurring in the Stirling Range to Ravensthorpe area. New collections have only slightly extended the main range of *Cryptandra intermedia* but atypical specimens collected from over 250 km further south-east in the Stirling Range and near Ravensthorpe have increased the range of the whole *C. arbutiflora* complex. (Figure 1C)

Etymology. From the Latin words *inter* (between) and *medius* (middle). This member of the *Cryptandra arbutiflora* complex has a somewhat intermediate distribution in relation to those of the other members of the complex. It also has a somewhat intermediate morphology, particularly in its stem indumentum, which is very variable.

Affinities. Like *Cryptandra nola*, *C. pendula* and *C. stellulata*, *C. intermedia* is distinguished from all varieties of *C. arbutiflora* by its stellate-hairy rather than glabrous peduncles and by the hairy undersurface of its leaves. The four varieties of *C. arbutiflora* have only simple hairs on their stems whereas the other members of the *C. arbutiflora* complex have stellate hairs on the stems as well as, or instead of, simple hairs.

Of the other three species recognised, *Cryptandra stellulata* is the closest in morphology to *C. intermedia* but its stems differ in having a sparse covering of minute stellate hairs whereas *C. intermedia* has mainly simple hairs of a variety of sizes and its few stellate hairs are larger than those of *C. stellulata*. The simple hairs in *C. intermedia* are either straight and patent or curved towards the apex of the stem and may be all of the same size, or there may be a mixture of long and minute hairs.

Unlike *Cryptandra nola*, *C. pendula* and *C. stellulata*, *C. intermedia* has the stigmatic lobes very small and it often has a short style in relation to its anther height.

Notes. One of the new south-eastern collections (*E.J. Croxford* 4281) is from near Mt Trio in the Stirling Range while the rest are from near Ravensthorpe. The Stirling Range specimen has occasional very large stiff hairs on the upper surface of the leaf, a character also occasionally found in specimens from the main area of distribution of *Cryptandra intermedia*. The other specimens are from south of Ravensthorpe and have been allocated the informal name *Cryptandra* sp. Ravensthorpe (*G.F. Craig* 6309). They have short patent hairs covering the upper surface of the leaf, similar to the leaves of some specimens from the northern area. Despite their great isolation, all of the south-eastern specimens seem to fit easily within the wide range of variation in leaf indumentum already recorded for *Cryptandra intermedia*.

The Mt Trio specimen, which is not in fruit, differs from the northern specimens in its shorter floral tube and style. It shows little similarity to the Ravensthorpe specimens which have a long style. The *Cryptandra* sp. Ravensthorpe specimens have a larger seed than any of the fruiting specimens examined from the northern area. Whether this difference in seed size is significant remains to be determined. More collections are needed in the south-eastern region to determine what formal taxonomic status, if any, these new variants should have.

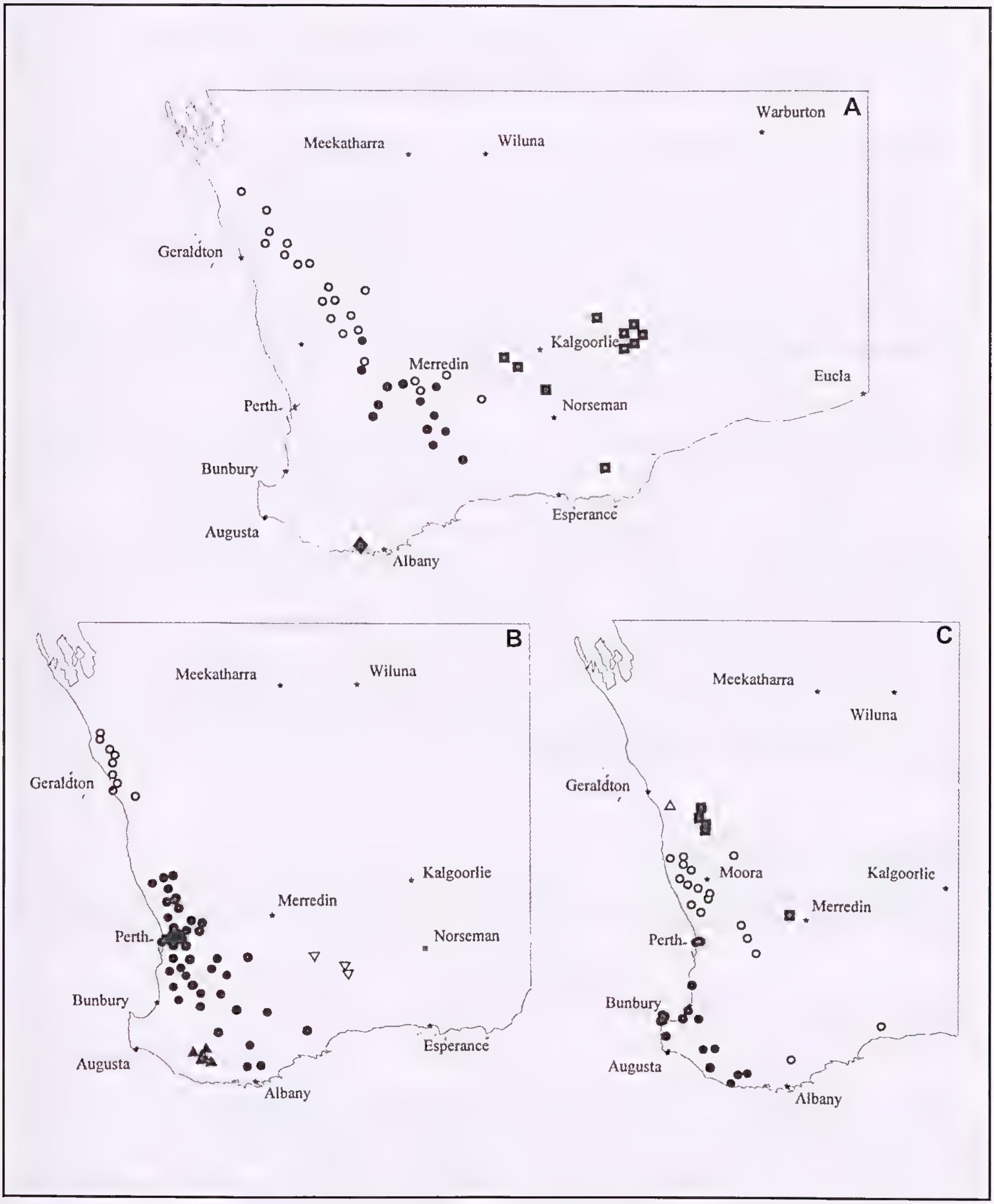

Figure 1. Geographic distributions. A – *Cryptandra apetala* Ewart & Jean White var. *apetala* ○, *C. apetala* var. *anomala* Rye ●, *C. congesta* Rye ♦ and *C. distigma* Rye ■; B – *Cryptandra arbutiflora* var. *arbutiflora* ●, *C. arbutiflora* var. *borealis* ○, *C. arbutiflora* var. *pygmaea* ▲ and *C. intonsa* Rye ▽ ; C – *Cryptandra arbutiflora* var. *tubulosa* ●, *C. intermedia* ○, *C. pendula* △ and *C. stellulata* ■ .

3. Cryptandra nola Rye, *Nuytsia* 10: 275–276 (1995). *Type:* 1.4 km east of railway crossing east of Mullewa, Western Australia, 6 August 1994, *S.J. Patrick* 1945 (*holo:* PERTH 04160169; *iso:* CANB, MEL).

Illustration. Rye (1995b: fig. 4J–M).

Description as given in Rye (1995b: 275–276) except for the following additions. *Leaves* 1.2–3.5 mm long, with antrorse simple hairs on the midvein of undersurface visible even when the margins are concealing the remainder of the leaf undersurface, which is densely minutely stellate-hairy. *Peduncles* densely stellate-hairy. *Style* 2–2.8 mm long, exserted, the base stellate-hairy; stigmatic lobes well developed. *Fruit c.* 2/3 superior, *c.* 3 mm long, superior part sparsely minutely stellate-hairy. *Seeds* not seen at maturity, the largest seen *c.* 2.4 mm long; body *c.* 2.1 × 1.2 mm, medium brown above a dark base; aril 0.5–0.6 mm long, whitish, 3-lobed.

Selected specimens examined. WESTERN AUSTRALIA: Reserve No. 22125, located on Pintharuka Dam Rd, 10 Sep. 1993, *R.J. Colum* 4 (PERTH); Ogilvie East Rd, at bend in the road 6.6 km W of Horan Rd, 19 Aug. 2003, *B.L. Rye* 238039 *& M.E. Trudgen* (PERTH); Old Pinjar Rd, 4.5 km NE of start of road and 2.6 km from intersection with Docherty Rd, 9 Sep. 2003, *B.L. Rye* 239044 *& M.E. Trudgen* (PERTH); 2.5 km SW of Croot Rd on Canna North-East Rd, 9 Sep. 2003, *B.L. Rye* 239055 *& M.E. Trudgen* (PERTH).

Distribution. Extends from East Yuna Reserve south-east to Canna. (Figure 2A)

Conservation status. Previously this species had a conservation status of Priority Two. Recent collections have increased the number of known populations and it is now assessed as Priority Three.

4. Cryptandra pendula Rye, *sp. nov.*

Ramuli stellate-pilis; flores glabri, tubus 4–5 mm longi; ovarium triloculare; fructus magnopere inferiore.

Typus: Allanooka area [precise locality withheld], Western Australia, 3 Aug. 2005, *J. Else* 21 (*holo:* PERTH 07292627).

Shrubs c. 0.75 m high, no spinescent branchlets seen. *Young stems* densely stellate-hairy at first, apparently sometimes also with a few simple patent hairs; longest hairs 0.2–0.3 mm long. *Stipules* 0.8–1.3 mm long, acute to acuminate, glabrous. *Petioles* 0.7–1.1 mm long, well exserted from stipules. *Leaf blades* linear or almost linear in outline, 8–10 × 0.6–1.3 mm, with a recurved mucro 0.1–0.2 mm long; lower surface often concealed by the recurved to revolute margins, densely white stellate-hairy; upper surface smooth or tuberculate, glabrous. *Peduncles* densely stellate-hairy. *Bracts c.* 13, arising over a distance of *c.* 1 mm long, broadly ovate to oblong-elliptic, glabrous; the inner ones *c.* 1.4 mm long, obtuse, becoming torn and erose. *Flowers* commonly 5–15 per branchlet in a spike-like arrangement, pendulous, white. *Floral tube* 4–4.5 mm long (enlarging to 4–5 mm in fruit), glabrous; adnate part of tube hidden by bracts, *c.* 1 mm long; free part 3–3.5 mm long. *Sepals c.* 1.6 mm long, glabrous. *Petals c.* 1 mm long; claw *c.* 0.2 mm long. *Disc* with stellate hairs *c.* 0.3 mm long. *Ovary* 3-locular; summit glabrous. *Style c.* 3 mm long, included, glabrous; stigmatic lobes scarcely extending laterally from apical part of style. *Fruit c.* 4/5-inferior, *c.* 2.6 mm long, glabrous except for the hairy disc. *Seeds* not seen at maturity, the largest *c.* 2.2 mm long, with a whitish 3-lobed aril *c.* 0.8 mm long.

Distribution and habitat. Known from a single locality in the Allanooka area, south-east of Geraldton. Recorded on an upper hill slope in lateritic gravel with several species of *Melaleuca* and occasional *Casuarina campestis* shrubs. (Figure 1C)

Flowering period. July to August.

Conservation status. Conservation Codes for Western Australian Flora: Priority One. This recently discovered species is known from a single locality where it was described as being "occasional". As this population is in an area that has not been surveyed very thoroughly, it seems likely that further populations will be discovered.

Etymology. From the Latin word *pendulus* (drooping) as this species has pendulous flowers and fruits.

Affinities. As far as it is known so far, this species differs from its closest relatives, *C. arbutiflora*, *C. intermedia*, *C. nola* and *C. stellulata*, in its lack of spinescent branchlets, but more collections are needed to confirm that it is never spinescent. It differs from *C. nola* in its longer glabrous flowers and from *C. arbutiflora* in its dense stellate indumentum on the young stems and on the undersurface of the leaves. It is unusual in the genus as a whole in having the ovary largely inferior. Together with the largest-flowered specimens known for *C. arbutiflora* var. *tubulosa*, *C. pendula* has the longest flowers known for the genus in Western Australia, although some eastern Australian species have even longer flowers.

Notes. This new taxon, previously known as *Cryptandra* sp. Allanooka (*J. Else* 21), occurs south-east of Geraldton (Figure 1C) in an area where no other members of the *Cryptandra arbutiflora* complex have been recorded. Although *C. pendula* is known from only one specimen, its very distinctive flowers and fruits indicate that it should be recognised at the species level. Mature seeds are needed and the species needs to be surveyed to assess its conservation status.

5. **Cryptandra stellulata** Rye, *sp. nov.*

Cryptandrae nolae affinis sed floris glabrus et foliorum longioribus, magis glabrus differt.

Typus: Billeranga Hills Site M1C, 17 km W of Morawa, Western Australia, 20 August 1997, *F. Keast* M1C 253 (*holo:* PERTH 05037174).

Shrubs 0.3–1 m high, commonly with spinescent branchlets 6–12 mm long. *Young stems* stellate-hairy at first but hairs minute, usually less than 0.1 mm long, and often scattered, with no simple hairs present, becoming glabrous. *Stipules* 0.8–1 mm long, acute to acuminate, glabrous. *Petioles* 0.6–0.8 mm long, well exserted from stipules. *Leaf blades* narrowly oblong to linear in outline, 4–12 × 0.7–1.8 mm, with a recurved or erect mucro up to 0.3 mm long; lower surface usually concealed by the recurved to revolute margins, densely or moderately densely stellate-hairy; upper surface smooth or with minute acute broad protrusions, glabrous. *Peduncles* densely stellate-hairy. *Bracts c.* 8, broadly ovate to oblong-elliptic, closely packed at base of floral tube and patent, the inner ones *c.* 1.5 mm long, obtuse, becoming torn and erose. *Flowers* usually 2–12 per branchlet in a spike-like arrangement, white. *Floral tube* 1.7–2.5 mm long (not seen in fruit); adnate part of tube short and hidden below bulging base of free part, so not contributing to length of tube. *Sepals* 1.3–1.5 mm long, glabrous. *Petals c.* 1 mm long; claw 0.1–0.2 mm long. *Disc* with stellate hairs *c.* 0.2 mm long. *Ovary* 3-locular; summit stellate-hairy, often densely so, with hairs *c.* 0.2 mm long. *Style* 2.2–2.5 mm long, slightly to well exserted beyond stamens, glabrous except at base; stigmatic lobes well developed, *c.* 0.3 m long. *Fruit* not seen at maturity but *c.* half-inferior when partly developed.

Other specimens examined. WESTERN AUSTRALIA: 5 km N of Carnamah, 9 Aug. 2000, *S. Hamilton-Brown s.n.* (PERTH); 8 km N of Carnamah on the Carnamah–Perenjori road, 10 Aug. 2000, *S. Hamilton-Brown s.n.* (PERTH); 37 km W of Morawa, 18 Aug. 1997, *F. Keast* M7B 225 (PERTH); Bencubbin–Kellerberrin road at 1.9 km N of Durokoppin Rd, 31°24'S, 117°46'E, 23 Aug. 2000, *S.J. Patrick* 3748 (PERTH); 13 km NE of Yandanooka, off Moffet Rd on private land, Sep. 1998, *R. Soullier* 616 (PERTH).

Distribution and habitat. Occurs mainly in the Morawa area, extending from Yandanooka to Carnamah, with an isolated record south-east near Kellerberrin, growing on the crests of slopes of hills with granite, laterite or other rock substrates. (Figure 1C)

Flowering period. August to September.

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. Although only collected for the first time in 1997, this taxon is now known from at least six closely clustered populations and from an additional locality *c.* 300 km away. There is also an unconfirmed record from near Moora.

Etymology. From the Latin word *stellulatus* (with little stars) as this species is distinguished from the other members of the *C. arbutiflora* complex by the sparse indumentum of minute stellate hairs on its stems.

Affinities. This taxon was previously confused with *Cryptandra intermedia* but differs in its sparser minute stellate indumentum on the young stems, its usually more exserted style and its longer stigmatic lobes; it probably also tends to have a larger habit. It is also very closely related to *Cryptandra nola*, differing in its glabrous flowers, the more discrete stellate hairs on its stems, its glabrous outer bracts and its generally longer and less hairy leaves. In *C. nola*, unlike in *C. stellulata*, there are simple hairs on the midvein of the leaf undersurface and the upper leaf surface is often minutely stellate-hairy.

Cryptandra stellulata is largely geographically distinct from both *C. nola* and *C. intermedia*, occurring mainly south of *C. nola* and mainly inland of *C. intermedia*.

Notes. Previously known as *Cryptandra* sp. Morawa (*F. Keast* M1C 253). Fruiting material with mature seeds is needed for this species to complete its description.

The *Cryptandra minutifolia* complex

A taxonomically difficult species group referred to here as the *Cryptandra minutifolia* complex is characterised by having densely clustered leaves with a recurved mucro and usually with the petiole completely hidden by the stipules, non-spinescent branchlets, and large flowers each surrounded by many involucral bracts. The floral tube is usually fully or almost fully concealed within the tight involucre of bracts in flower but sometimes emerges in fruit, although, as the floral tube is already long in flower, it does not enlarge much in proportion to its length in flower and possibly sometimes does not enlarge at all. As is common in the genus *Cryptandra*, the petals are minutely papillose on the outer surface, the fruit is half-inferior and the large aril always has its 3 lobes well developed.

When this complex was examined by Rye (1995b), four taxa were formally recognised as *Cryptandra aridicola*, *C. leucopogon*, *C. minutifolia* subsp. *brevistyla* and *C. minutifolia* subsp. *minutifolia*. Further study of this complex following the collection of many extra specimens has resulted in the recognition of three new taxa, *C. beverleyensis*, *C. crispula* and *C. exserta*. The first two of these new species undoubtedly belong to the complex but the last of them is somewhat atypical, and so six or seven taxa are now recognised in the *Cryptandra minutifolia* complex.

The existence of a few atypical specimens that might be hybrids or additional new taxa continue to confuse the picture, and the group needs further study and collection, especially of good fruiting material with mature seeds. All members of the complex are listed below and full descriptions are given for two new species and the two previously published taxa in which they had previously been included.

6. Cryptandra aridicola Rye, *Nuytsia* 10: 264–265 (1995). *Type:* Edjudina Station, Western Australia, 9 July 1989, *H. Pringle* 2380 (*holo:* PERTH 01177591; *iso:* CANB, MEL, PERTH 05929105).

Description and illustration. Rye (1995b: fig. 3F–K).

Selected specimens examined. WESTERN AUSTRALIA: Boingaring Rocks, Dundas Nature Reserve, 143.5 km E from Esperance–Norseman highway along Telegraph Track, 12 July 1995, *G.F. Craig* 3211 (PERTH); 1 km E of Goongarrie Hill, 5 July 1995, *R.J. Cranfield* 9840 (PERTH); Newman Rock, 50 km W of Balladonia on Eyre Highway, 26 Aug. 1997, *S. Donaldson* 1300 (PERTH). SOUTH AUSTRALIA: no material examined to date but recorded from 29 km E of Serpentine Lakes, Great Victoria Desert, 24 Aug.1980, *D.E. Symon* 12525 (AD).

Notes. New Western Australian material has extended the known geographic distribution somewhat (Figure 2A) but has not significantly altered the range of morphology previously recorded for this species. Much more significant is a new collection from South Australia just east its border with Western Australia (J. Kellermann pers. comm.). The full distribution of *C. crispula* occurs within the range of *C. aridicola* but there are no known intermediates.

Cryptandra aridicola is one of the members of the *Cryptandra minutifolia* complex for which mature seeds have not yet been collected. This species is distinguished from the remainder of the complex by its long petal claws and long style. It also tends to have longer narrower sepals.

7. **Cryptandra beverleyensis** Rye, *sp. nov.*

Cryptandrae minutifoliae affinis sed foliis longioribus et floribus minis pilosis differt.

Typus: Beaufort River Water Reserve, Arthur River to Kojonup, Western Australia, 31 Aug. 2003, *G.J. Keighery & B.J. Keighery* 508 (*holo:* PERTH 007122950; *iso:* CANB).

Shrubs 0.4–1.3 m high. *Branchlets* not spinescent. *Young stems* densely hairy at first with a white indumentum of stellate and simple hairs (the two types of hairs somewhat tangled and closely pressed to the stems making them difficult to distinguish), becoming glabrous. *Stipules* 1.2–1.7 mm long, acute to acuminate, ciliate, outer surface often with a few hairs along midvein. *Petioles* 0.3–0.5 mm long, concealed by united base of stipule pair or shortly exserted. *Leaf blades* narrowly oblong, the larger ones 2.5–4 × 0.4–0.7 mm, with a recurved mucro 0.1–0.3 mm long; lower surface concealed by the recurved to revolute margins, densely white-hairy; upper surface smooth or with minute acute broad protrusions, glabrous. *Bracts* 12–14, broadly ovate to oblong-elliptic, ciliate; the inner ones 2.3–3.5 mm long, obtuse, ciliolate, with outer surface glabrous. *Flowers* usually 2–8 per branchlet in a terminal cluster or short spike-like arrangement, white. *Floral tube* 2.5–3.5 mm long (up to 4 mm long in fruit); adnate part of tube 0.6–0.8 mm long, largely glabrous (with scattered stellate hairs mainly between the ribs) to densely hairy; free part 2–3 mm long, glabrous throughout or with hairs similar to those on sepals in distal part or more densely hairy in distal half. *Sepals* 2–3 mm long, largely glabrous but with small hairs in central part to hairy throughout with a close stellate indumentum and simple hairs; simple hairs antrorse to appressed, 0.1–0.3 mm long. *Petals* 1.3–1.6 mm long; claw 0.2–0.4 mm long. *Disc* with stellate hairs 0.2–0.3 mm long. *Ovary* 3-locular; summit with stellate hairs 0.4–0.5 mm long. *Style* 2.5–3.5 mm long, glabrous except at extreme base. *Fruit* fully concealed within the floral tube and bracts, half-inferior, *c.* 3 × 2.2 mm, stellate-hairy on summit. *Seeds* not seen at maturity, the largest seen *c.* 2.5 mm long with a body *c.* 2.2 mm long and a 3-lobed whitish aril *c.* 0.6 mm long.

Other specimens examined. WESTERN AUSTRALIA: 10 km SW of Goomalling on Goomalling–Toodyay road, 17 Sep. 1994, *P. Armstrong s.n.* (PERTH); Doyle Rd, SE of Bokal, 29 Aug. 1994, *V. Crowley* DKN 373 (PERTH); Doyle Rd, SE of Bokal, 17 Aug. 1995, *V. Crowley* DKN *s.n.* (PERTH); Beecroft Rd, *c.* 500 m E of Forrest Rd intersection, Goomalling, 26 Sep. 2000, *R. Davis* WW10-34 (PERTH); Kellerberrin, York District, 4 Sep. 1897, *A.E. Lankester s.n.* (PERTH); Beverley Airfield Reserve, *c.* 1 km S of Beverley townsite, 18 Sep. 2000, *M. Ochtman & D. Lynch* 48 (PERTH); Kokeby Reserve, 22 Sep. 2001, *M. Ochtman* KO492 (PERTH).

Distribution and habitat. Distributed in the area surrounding Beverley in the South West Botanical Province of Western Australia, extending from Goomalling south to Beaufort River and eastwards to Kellerberrin. Occurs in clay soils sometimes also with sand, often with lateritic gravel, in eucalypt woodlands, often with Wandoo or Salmon Gum dominant. (Figure 2B)

Flowering period. August to September.

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. The known range of this species is *c.* 250 km. Except for one very old collection from Kellerberrin, this taxon is represented at PERTH by eight specimens collected from the mid 1990s onwards, all or mostly from different localities. There is also an older collection from near Narrogin (*H. Eichler* 15858) housed at AD (J. Kellermann pers. comm.). The species is not as common as many other *Cryptandra* species from the same general area but is perhaps poorly collected rather than really needing to be included on the priority list.

Etymology. Named after the town of Beverley where this species has been collected and which is fairly central to its known range.

Affinities. This species is a largely geographically separated member of the *Cryptandra minutifolia* complex, occurring further west and tending to have its flowers less hairy than all other members of the complex. Its leaves are almost as long and narrow on average as those of *C. leucopogon* but that species differs in having terminal long tufts of hairs on the sepals and long hairs on the ovary summit.

Notes. When *Cryptandra minutifolia* subsp. *minutifolia* was described in Rye (1995b), the presence of an atypical specimen from Kellerberrin with long leaves was noted. The Kellerberrin specimen and a number of recent additional collections of *Cryptandra beverleyensis* were later housed under the name *Cryptandra* sp. Beverley (*M. Ochtman & D. Lynch* 48).

The description of the fruit and seeds given above were based on an atypical collection (*R. Davis* WW10-34), which was the only one collected in mature fruit. This specimen is atypical in having long pedicels exserted from the stipule pairs and needs further study.

8. **Cryptandra crispula** Rye, *sp. nov.*

Cryptandrae minutifoliae affinis sed foliis longioribus, glaucis, et pilis sepalorum longioribus differt.

Typus: 76 km E of Norseman on Eyre Highway, Western Australia, 16 August 1995, *R.J. Cranfield* 10039 (*holo:* PERTH 04390350; *iso:* MEL).

Shrubs 0.25–0.9 m high. *Branchlets* not spinescent. *Young stems* with a dense matted indumentum at first of long very fine hairs, the individual hairs too tangled for their type (whether simple or stellate) to be readily determined but both stellate hairs and simple present, becoming glabrous. *Stipules* 1.5–2.5 mm long, acute to acuminate, ciliate. *Petioles c.* 0.2 mm long. *Leaf blades* narrowly oblong, 2.5–4 × 0.6–0.8 mm, with recurved to revolute margins completely or almost completely concealing the lower surface, with a recurved whitish mucro 0.2–0.4 mm long; lower surface white-hairy. *Bracts* 11 or 12, broadly ovate to oblong-elliptic, inner surface of outer bracts with long hairs along midvein; inner bracts 3–3.5 mm long, obtuse, long-ciliate; outer surface glabrous around margin, minutely hairy inside. *Flowers* usually 2–5 per branchlet in a cluster, white. *Floral tube* 2–2.3 mm long (enlarging slightly in fruit), densely stellate-hairy; adnate part of tube 0.7–0.9 mm long, densely minutely stellate-hairy; free part 1.2–1.6 mm long, rather densely hairy in distal half, becoming more sparsely hairy below. *Sepals* 2–2.2 mm long, very densely hairy with stellate and crisped/tangled simple hairs, the apex hidden by a tuft of hairs 1–1.5 mm long. *Petals* 0.9–1.1 mm long; claw 0.2–0.3 mm long. *Disc* with stellate hairs *c.* 0.2 mm long. *Ovary* 3-locular; summit with stellate hairs 0.25–0.35 mm long. *Style* 0.9–1.2 mm long, extreme base with stellate hairs. *Fruit* fully concealed within the closed sepals and bracts but probably sometimes partially exserted from floral tube, *c.* half-inferior, *c.* 2.5 × 2–2.3 mm, stellate-hairy. *Seeds* not seen at maturity, the largest *c.* 2.3 mm long, with a body *c.* 1.7 mm long and a whitish 3-lobed aril *c.* 0.8 mm long.

Other specimens examined. WESTERN AUSTRALIA: 88.9 km E along Eyre Highway from Norseman, 17 July 2002, *R. Davis* 10312 (AD, NSW, PERTH); 320 mile peg on Great Eastern Highway [*c.* 13 km W of Bullabulling], 10 Oct. 1974, *H. Demarz* 5269 (PERTH); 75 km ENE of Norseman, 9 Sep. 1973, *N.N. Donner* 4655 (PERTH); 19 km SSW Queen Victoria Rock, 24 Sep. 1993, *G.J. Keighery* 12954 (PERTH); 26 km SE of Karonie, 12 Aug. 1981, *K.R. Newbey* 8500 (CANB, PERTH).

Distribution and habitat. Distributed in the South Western Interzone of Western Australia in the region surrounding Lake Lefroy. Extends from near Bullabulling east to near Karonie and south-east to near Fraser Range. Recorded mainly in sandy soils. (Figure 2D)

Flowering period. July to September.

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. Although known only from six collections, this species is unlikely to be endangered as it occurs in a poorly known inland area where access is often difficult. The known distribution of this taxon is over 200 km long.

Etymology. From the diminutive of the Latin word *crispus* – crinkled or curled, referring to the crisped long hairs on the sepals.

Affinities. This member of the *Cryptandra minutifolia* complex has somewhat glaucous leaves of a similar length to those of *C. aridicola*, long hairs terminating the sepals as in *C. leucopogon* and a short style like that of *Cryptandra minutifolia* subsp. *brevistyla*. It differs from all these taxa in its greater tendency to have the hair tufts on the sepals crisped.

Previously this species was included within *Cryptandra minutifolia* subsp. *brevistyla* because of the existence of a few specimens that bridged the gap between the two taxa to some degree. See the notes under *C. minutifolia* subsp. *brevistyla* regarding two atypical specimens that have leaves similar in length to those of *C. crispula*. Placement of those specimens needs to await further collection of them but, on the basis of their distribution, broad green leaves and shorter hairs on the sepals, they certainly fit better in *C. minutifolia* subsp. *brevistyla* and do not appear to affect the recognition of *C. crispula*.

9. Cryptandra leucopogon Meisn. ex Reissek *in* J.G.C. Lehmann, Pl. Preiss. 2: 287–288 (1848). *Type:* Gordon River, Western Australia, 7 November 1840, *L. Preiss* 752 (*holo:* LD).

Selected specimens examined. WESTERN AUSTRALIA (all PERTH): Reserve 15266 in the Toolibin Catchment, 22 Nov. 1999, *E. Bennett & T. Sleep* 15266-40b; 3.1 km W of Floater Rd on Hayes Rd, *c.* 42 km SE of Lake King township, 7 Nov. 1996, *B.J. Lepschi* 3234 *& T.R. Lally*; 0.6 km N of Hyden-Norseman road on track to North Ironcap, 6 Nov. 2004, *B.L. Rye* 241184 *& M.E. Trudgen*.

Affinities. This is the most clearly distinct member of the *Cryptandra minutifolia* complex, differing from all the rest by its more or less cylindrical leaves up to 5 mm long, very long hairs on the ovary summit and its sepal indumentum. The sepals have a protruding apical tuft of hairs 1 mm or more long and at least four times longer than the indumentum occurring below.

Notes. The distribution of this species (Figure 2B) overlaps the ranges (Figure 2B–E) of several other members of the *Cryptandra minutifolia* complex but no hybrids are known.

Fruiting material of *Cryptandra leucopogon* has not been described previously. In fruit the style is *c.* 3.3 mm long and its basal third is densely stellate-hairy. The fruit is fully concealed within the floral tube and bracts, *c.* half-inferior, 1.7–2.3 × 1.5–1.6 mm and densely hairy on the summit. Seeds are 1.6–1.7 mm long, with a body 1.2–1.3 × 0.6–0.7 mm and a whitish, 3-lobed aril 0.5–0.8 mm long. The testa has a very dark base and is pale to uniformly golden brown above or with the margin and centre somewhat differently coloured.

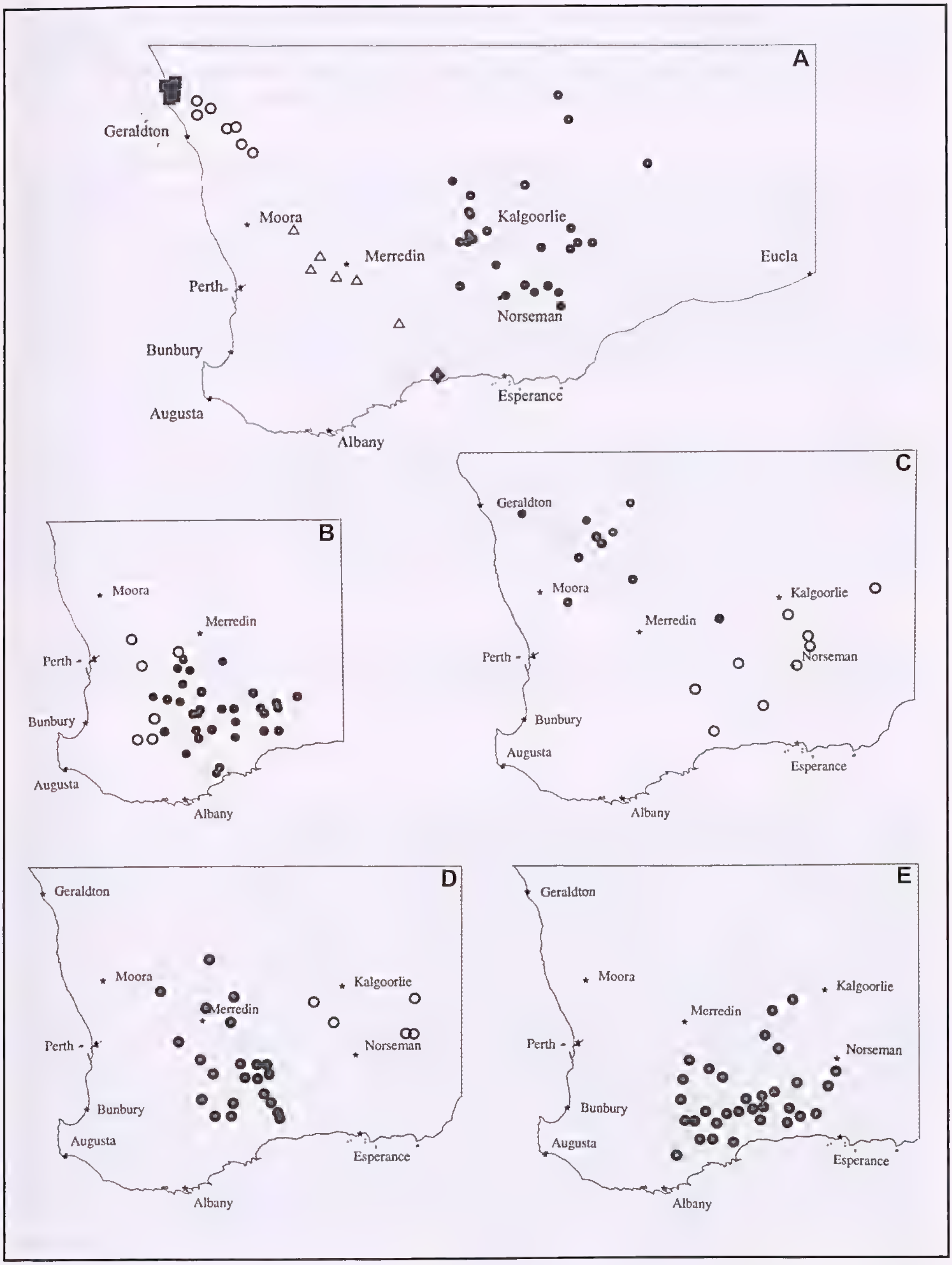

Figure 2. Geographic distributions. A – *Cryptandra aridicola* ●, *C. craigiae* ♦ , *C. dielsii* △ , *C. glabriflora* Benth. ■ and *C. nola* ○; B – *Cryptandra beverleyensis* ○ and *C. leucopogon* ●; C – *Cryptandra graniticola* Rye ○ and *C. micrantha* ●; D – *Cryptandra crispula* ○ and *C. minutifolia* subsp. *minutifolia* ● ; E – *Cryptandra minutifolia* subsp. *brevistyla*.

10. Cryptandra minutifolia Rye, *Nuytsia* 10: 273 (1995). – *Cryptandra parvifolia* Turcz., *Bull. Soc. Imp. Nat. Moscou* 31: 459 (1858), *nom. illeg. non Cryptandra parvifolia* (Hook.) Hook.*f. Type:* south-western Australia [from north of Moore River to King George Sound and West Mt Barren, Western Australia], 1847, *J. Drummond* coll. 4, n. 156 (*holo:* KW *n.v.*; *iso:* PERTH 01599313).

Notes. When this species was first described in Rye (1995b), there were far fewer specimens available for study. The ranges of *Cryptandra minutifolia* subsp. *minutifolia* and subsp. *brevistyla* appeared to have only a small overlap and the occurrence of a few intermediates in the area of overlap suggested that subspecies status was appropriate. The removal of atypical specimens (described here as *C. beverleyensis* and *C. crispula*) and the addition of more widely collected specimens of subsp. *minutifolia* and subsp. *brevistyla* have shown the two subspecies to have less variable morphology than previously thought and a larger area of overlap in their ranges. Most specimens can be readily identified but specimens of intermediate morphology are fairly common in the area where the distributions overlap.

Morphological differences between the typical specimens of the two subspecies seem to be as great as those between each of them and the new taxa *C. beverleyensis* and *C. crispula*, but there appear to be too many intermediates to warrant their recognition as separate species. As far as it is currently known, the fruiting material of the two taxa separates them more effectively than flowering material, with differences in floral tube length and seed size, but this may just reflect the paucity of fruiting material. Further fruiting collections and field studies of the two taxa seem to be needed to assess their taxonomic status further.

10a. Cryptandra minutifolia Rye subsp. minutifolia

Illustration. Rye (1995b: fig. 3L–N).

Shrubs 0.2–0.6(0.9) m high. *Branchlets* not spinescent. *Young stems* densely hairy at first with a white indumentum of stellate and simple hairs (the two types of hairs somewhat tangled and closely pressed to the stems making them difficult to distinguish), becoming glabrous. *Stipules* up to 2.5 mm long, acute to acuminate, ciliate, outer surface often with a few hairs along midvein. *Petioles* 0.2–0.3 mm long, concealed by united base of stipule pair. *Leaf blades* appearing sessile, oblong-elliptic, 0.8–1.7 × 0.6–0.8 mm, with a recurved mucro 0.1–0.2 mm long; lower surface concealed by the recurved to revolute margins, densely white-hairy; upper surface smooth or with minute acute broad protrusions, glabrous. *Bracts* 12–14, broadly ovate to oblong-elliptic, ciliate; the inner ones 2.5–3.5 mm long, obtuse, ciliolate, with outer surface glabrous. *Flowers* usually 2–5 per branchlet in a terminal cluster but sometimes more numerous, white. *Floral tube* 2.5–3.5 mm long (enlarging to 3.5–4 mm long in fruit); adnate part of tube *c.* 0.7 mm long, largely glabrous (with stellate hairs mainly between the ribs) to densely hairy; free part 1.8–2.8 mm long, glabrous throughout or with hairs similar to those on sepals in distal part or more densely hairy in distal half. *Sepals* 2.7–3.5 mm long, with a close stellate indumentum and simple hairs; simple hairs antrorse to appressed, 0.3–0.5 mm long. *Petals c.* 1.1 mm long; claw 0.2–0.4 mm long. *Disc* with stellate hairs 0.2–0.3 mm long. *Ovary* 3-locular; summit with stellate hairs 0.2–0.4 mm long. *Style* 2.5–3.6 mm long, glabrous in distal half, basal half or extreme base densely stellate-hairy. *Fruit* fully concealed within the floral tube and bracts, *c.* half-inferior, 2.3–2.5 × 2–2.3 mm (possibly not full-sized as not seen after dehiscence), densely hairy. *Seeds* not seen at maturity, the largest *c.* 2.3 mm long, with a body *c.* 1.7 mm long and a whitish, 3-lobed aril 0.6–0.8 mm long.

Selected specimens examined. WESTERN AUSTRALIA: Bounty Mine, *c.* 3 km S of North Ironcap, 7 Sep. 1994, *G. Barrett s.n.* (PERTH); S side of Bairstow Rd, 200 m W of Fourteen Mile Rd, Lakeland Nature Reserve, *c.* 33 km SW of Newdegate, 15 Oct. 1999, *G.J. Keighery & N. Gibson* 5548 (PERTH); Chiddarcooping Hill Nature Reserve, 29 Sep. 1984, *A.S. Weston* 14089 (PERTH).

Distribution. More or less restricted to the South West Botanical Province, extending from Manmanning east to Chiddarcooping Hill and south-east to Ravensthorpe Range. (Figure 2D)

Affinities. See notes under *Cryptandra minutifolia* subsp. *brevistyla.*

Notes. The description of *Cryptandra minutifolia* subsp. *minutifolia* in Rye (1995b: 275) is accurate except for the outlying large measurements given for the leaves. It was noted there that the single specimen with these measurements was atypical, and that specimen is now included in the new species *C. beverleyensis*.

Previously only flowering material had been seen. Three recently incorporated specimens that have almost mature fruits are cited above and measurements taken from them have been added to the description of this taxon. These three fruiting specimens have the style 3–3.5 mm long, with its basal half densely stellate-hairy.

10b. Cryptandra minutifolia subsp. **brevistyla** Rye *Nuytsia* 10: 274–275 (1995). *Type:* 2 km SW of Mt Madden, which is 22 km SE of Lake King township, Western Australia, 6 August 1968, *P.G. Wilson* 6813 (*holo:* PERTH 01507540; *iso:* CANB, MEL).

Illustration. Rye (1995b: fig. 3F–K).

Shrubs (0.1)0.2–0.6(1) m high. *Branchlets* not spinescent. *Young stems* very densely hairy at first with a white indumentum of stellate and simple hairs (the two types of hairs tangled and difficult to distinguish), becoming glabrous. *Stipules* 1.3–2.5 mm long, acuminate, outer surface often hairy. *Petioles* 0.2–0.3 mm long, concealed by united base of stipule pair. *Leaf blades* appearing sessile, oblong-elliptic, usually 1–2 × 0.6–0.8 mm, with a recurved mucro 0.1–0.2 mm long; lower surface concealed by the recurved to revolute margins, densely white-hairy; upper surface smooth or with minute acute broad protrusions, glabrous. *Bracts* (8)9–12, broadly ovate to oblong-elliptic; inner ones 2–3 mm long, obtuse, ciliate or long-ciliate, with outer surface minutely hairy or glabrous. *Flowers* usually 3–10 but sometimes 1 or 2 per branchlet in a terminal spike-like or head-like cluster, white or occasionally pink. *Floral tube* 1.5–2.3 mm long (scarcely enlarging or up to 3 mm long in fruit); adnate part of tube 0.6–0.8 mm long, densely hairy; free part 1–1.5 mm long, glabrous throughout or with hairs similar to those on sepals in distal part or more densely hairy in distal half. *Sepals* 1.5–2.5 mm long, with a close stellate indumentum and simple hairs; simple hairs antrorse to appressed, the apical ones 0.3–0.5 mm long. *Petals c.* 1 mm long; claw 0.1–0.3 mm long. *Disc* with stellate hairs *c.* 0.3 mm long. *Ovary* 3-locular; summit with stellate hairs 0.3–0.4 mm long. *Style* 0.7–1.7(2.5) mm long, glabrous for most of length, base densely stellate-hairy. *Fruit* largely to fully concealed within the floral tube and bracts, *c.* half-inferior, 2–2.5 × 1.6–2.3 mm, densely hairy. *Seeds* 1.7–1.9 mm long; body 1.4–1.5 × 0.8–1.1 mm, with variable colouring, often dark with pale or darker markings around the border, sometimes pale with prominent darker mottling; aril 0.6–1.1 mm long, whitish or yellowish, 3-lobed.

Selected specimens examined. WESTERN AUSTRALIA: Cascade, 104 km NW of Esperance, 11 Aug. 1999, *R. Bruhn* 26/899 (PERTH); *c.* 7.5 km S along North Karlgarin Rd from intersection of Pederah Rd West, Pederah Nature Reserve, 20 Oct. 1999, *K. Kershaw* 2008 (PERTH); *c.* 41 km E of Newdegate on road to Lake King, 19 Oct. 1995, *B.J. Lepschi* 2207 (PERTH); 21.5 km by road *c.* E from Pingrup on Pingrup–Ravensthorpe road, 11 Oct. 1975, *G. Perry* 396 (PERTH); corner intersection of Airstrip Rd and Jilakin Rock Rd, *c.* 1 km E of Kulin, 16 Sep. 2001, *S. Murray* 491 (PERTH).

Long-leaved specimens: Frank Hann National Park, 6 Aug. 1978, *D. Monk* 131 (PERTH); 10 km Cascades Rd from E to W, 13 Aug. 2000, *E. Tink* 502 (PERTH).

Distribution. Occurs in the South West Botnaicl Province and the South Western Interzone, extending from the Barker Lake area south-west to Kulin, south to the Stirling Range area and south-east to the Lort River area. Previously (Rye 1995) the range was given as extending from near Coolgardie to Stirling Range and east to Karonie but several of the inland specimens are now included under *Cryptandra crispula*. (Figure 2E)

Flowering period. July to September.

Notes. Two specimens that are somewhat intermediate between *Cryptandra crispula* and *C. minutifolia* subsp. *brevistyla* are cited separately above. Their leaves are longer than usual for subsp. *brevistyla* and their sepals have the longer hairs concentrated towards the apex but less than 1 mm long so not as long as in *Cryptandra crispula*. These two specimens are on or near the easternmost edge of the range of subsp. *brevistyla*.

Three of the specimens cited above have fruits with mature seeds, including *G. Perry* 396 which has seeds that are as prominently mottled as those of many *Stenanthemum* species and a few *Spyridium* species. The other two fruiting specimens cited above have seed colouring more typical of the genus *Cryptandra*, but the seed illustrated in Rye (1995b: fig. 3K) is also mottled. This is the only taxon so far within the genus *Cryptandra* in which prominently mottled seeds have been reported, although it appears that mottled seeds are present only in about half of the specimens.

The *Cryptandra connata* complex

This complex comprises two species that have adjacent but non-overlapping ranges in the Eremaean Botanical Province of Western Australia, with one species extending slightly into the South West Botanical Province.

Both species were included in the genus *Blackallia* when it was first described by Gardner (1942), together with the unrelated species *B. biloba*, which had previously been described as *Cryptandra nudiflora* F. Muell. While *Cryptandra imbricata* was not described there as a distinct species, Gardner included it by citing a specimen of *C. imbricata* as an 'additional locality' under *Cryptandra* [as *Blackallia*] *connata*. Kellermann *et al.* (2007) have nominated *B. biloba* [= *Blackallia nudiflora* (F.Muell.) Rye & Kellermann] as the lectotype for *Blackallia* and excluded the other two species from *Blackallia* because they match the genus *Cryptandra* in their vegetative characters, inflorescence characters and the presence of stellate hairs on the disc.

Cryptandra connata and *C. imbricata* are atypical of *Cryptandra* in their disc orientation and fruit and seed characters. They have an obovoid ovary and a larger and more spreading disc, which is united at the base to the floral tube and has its free part appressed to the floral tube. Typically in *Cryptandra*, the ovary is more or less ellipsoid and the disc is united to, or at least closely appressed to, the ovary, which it covers or largely covers in the young flower.

Cryptandra connata and *C. imbricata* have a number of characters in common with the unrelated genus *Granitites* Rye (illustrated in Rye 1996: fig. 1). *Granitites* is closely related to *Alphitonia* and, like that genus, is currently unplaced in any of Richardson *et al.*'s (2000) tribes of Rhamnaceae. The most notable characters shared by the two *Cryptandra* species and *Granitites* are the stout spinescent branchlets, large beaked fruit and uniformly coloured seed body with a very large coloured aril. Spinescent branchlets are fairly common in *Cryptandra* but not the beaked fruit.

Typically in *Cryptandra*, the seed is darkened at the base and has a smaller clear-translucent or whitish to pale ferruginous aril, which is usually moderately large and with three distinct lobes. It appears that the very large colourful aril and similarly shaped fruits of this odd group of *Cryptandra* species and *Granitites* is a convergence in adaptation for a similar means of seed dispersal. The aril in these two *Cryptandra* species is far larger than any in the remainder of the Pomaderreae and also more prominent than in *Granitites*.

The lack of a darkened base to the seed in the two *Cryptandra* species distinguishes them not only from other *Cryptandra* species but also from other Pomaderreae, as the entire tribe is characterised by the presence of a darkened base to the seed. Perhaps this difference is not so much that there is a lack of dark pigment on the base of the seed as that the remainder of the seed has become darkened to match the base in *Cryptandra connata* and *C. imbricata*.

11. Cryptandra connata C.A. Gardner, *J. Roy. Soc. Western Australia* 14: 80, Plate 3H–L (1928). – *Blackallia connata* (C.A. Gardner) C.A. Gardner, *J. Roy. Soc. Western Australia* 27: 184 (1942). *Type:* Sandstone, Western Australia, 19 July 1927, *C.A. Gardner s.n.* (*lecto:* PERTH 01599259, here designated; *isolecto:* PERTH 01599240).

Typification. Two specimens at PERTH were labelled as type material without either being indicated as the holotype. Both sheets had similar material but one also had line drawings of many parts of the plant drawn onto it. The sheet with the drawings was therefore selected as the lectotype for this species.

12. Cryptandra imbricata Rye, *sp. nov.*

Cryptandrae connatae affinis sed bracteis et floribus magis pilosis, tubi florali breviore involucrum bracteorum vix excedenti differt.

Typus: 45 miles [72.4 km] north of Mullewa, Western Australia, 8 July 1969, *A.M. Ashby* 2881 (*holo:* PERTH 01515802; *iso:* CANB).

Shrubs spreading and often domed or rounded, with intricately interlaced divaricate branches, 0.5–1.5 m high. *Spinescent branchlets* mostly 5–20 mm long, with several clusters of leaves, the lower leaves of each cluster shed leaving a tight cluster of empty stipules with only the uppermost leaves attached. *Young stems* with a dense indumentum at first of stellate hairs and usually also larger antrorse to patent simple hairs 0.3–0.6 mm long, becoming glabrous. *Stipules* 0.5–1.3 mm long, acute to acuminate, ciliate, glabrous outside or with minute hairs at first. *Petioles* 0.4–0.6 mm long. *Leaf* *blades* narrowly oblong-elliptic to linear, 1.4–3.5 × 0.4–0.6 mm, with recurved to revolute margins partially to completely concealing the lower surface, scarcely mucronate; lower surface with large simple hairs along midvein, the hairs all or mostly antrorse or appressed, a minority sometimes patent. *Bracts* 11–14, broadly ovate to oblong-elliptic, the inner ones 2–3.3 mm long, obtuse or acute, prominently ciliate; outer surface usually with long fine antrorse hairs. *Flowers* 1–7 (usually 2–5) per branchlet in a spike-like cluster 7–11 mm wide, white. *Floral tube* 2.5–3.1 mm long (enlarging to 3–3.5 mm in fruit), densely stellate-hairy; adnate part of tube 0.3–0.5 mm long; free part 2.1–2.6 mm long, with a few long hairs. *Sepals* 2–3 mm long, densely stellate-hairy and with larger simple hairs at least towards the apex; simple hairs 0.4–0.8 mm long. *Petals* 1.3–1.6 mm long; claw 0.3–0.5 mm long. *Disc* with stellate hairs *c.* 0.2 mm long. *Ovary* 3-locular, superior, moderately densely hairy above the spreading densely hairy disc, with scattered simple hairs 0.3–0.6 mm long and more numerous shorter stellate hairs. *Style* 1.3–2.1 mm long. *Fruit* with the basal half concealed within the floral tube and bracts and the distal half exserted, 6–7 × 3.5–4 mm including the beak, densely hairy. *Seeds c.* 3.5 mm long; body *c.* 2 × 1.5 mm, very dark brown; aril *c.* 1.8 mm long, orange, truncate. (Figure 3A–G)

Other specimens examined. WESTERN AUSTRALIA: 30 miles [48 km] N of Cleary, 16 July 1967, *J.S. Beard* 4702 (PERTH); 50 miles [80 km] SW of Paynes Find, 8 Sep. 1938, *W.E. Blackall* 3857 (PERTH); Toolonga Nature Reserve, 33.4 km W of North West Coastal Highway on Butchers Track, 3 Sep. 1990, *A.H. Burbidge* 4507 (PERTH); 270 mile peg [9 km N of Paynes Find] on Paynes Find–Mount Magnet road, 20 July 1966, *A. Fairall* 1793 (PERTH); 9 km N of Paynes Find, 18 July 1994, *S.J. Patrick* 1884 (PERTH); 9.4 km N of Paynes Find, 18 July 1994, *S.J. Patrick* 1885 (PERTH); 12.5 km N of Paynes Find, 18 July 1994, *S.J. Patrick* 1886 (PERTH); Mount Gibson Station, 3.8 km from homestead road on track to Beanthiny Rock, 16 July 1996, *S.J. Patrick* 2664 (PERTH); Burnerbinmah Station, 800 m E of shearers quarters, 12 Sep. 1996, *S.J. Patrick* 2782 (PERTH); 2.3 km NE of Wurarga turnoff on Morawa–Yalgoo road, 20 Feb. 1997, *S.J. Patrick* 2905 (PERTH); Wuraga road, 700 m N of junction with Morawa–Yalgoo road, 20 Feb. 1997, *S.J. Patrick* 2909 (PERTH); 20 km N of Paynes Find, 1968, *S. Pfeiffer s.n.* (PERTH).

Distribution and habitat. Distributed mainly in the Eremean Botanical Province and extending slightly into the South West Botanical Province of Western Australia. Extends from Toolonga Nature Reserve south to Lake Moore. Occurs mainly in red sandy clay, one record from brown clayey soil on granite. (Figure 4A)

Flowering period. July to September.

Conservation status. Previously listed as Conservation Codes for Western Australian Flora: Priority Three, but now removed from the Priority List. The known range of this species is *c.* 400 km long, occurring in a range of landforms.

Etymology. From the Latin *imbricatus* – overlapping like roof tiles or shingles, referring to the overlapping bracts surrounding the base of the flower. Most *Cryptandra* species have this feature but it is better developed in *C. imbricata* than in many other species.

Affinities. Very closely related to *Cryptandra connata*, which occurs further inland and differs in having the outer surface of the bracts glabrous and the outside of the flowers glabrous except for a tuft of hairs towards the apex of each sepal. *Cryptandra connata* also has a longer floral tube and fairly erect sepals, the tube being approximately twice as long as the whorl of bracts and strongly 'pinched in' at the summit in flower. In *C. imbricata*, the floral tube is only slightly longer than the whorl of bracts and is less contracted at the summit, and the sepals are often widely spreading. A greater proportion

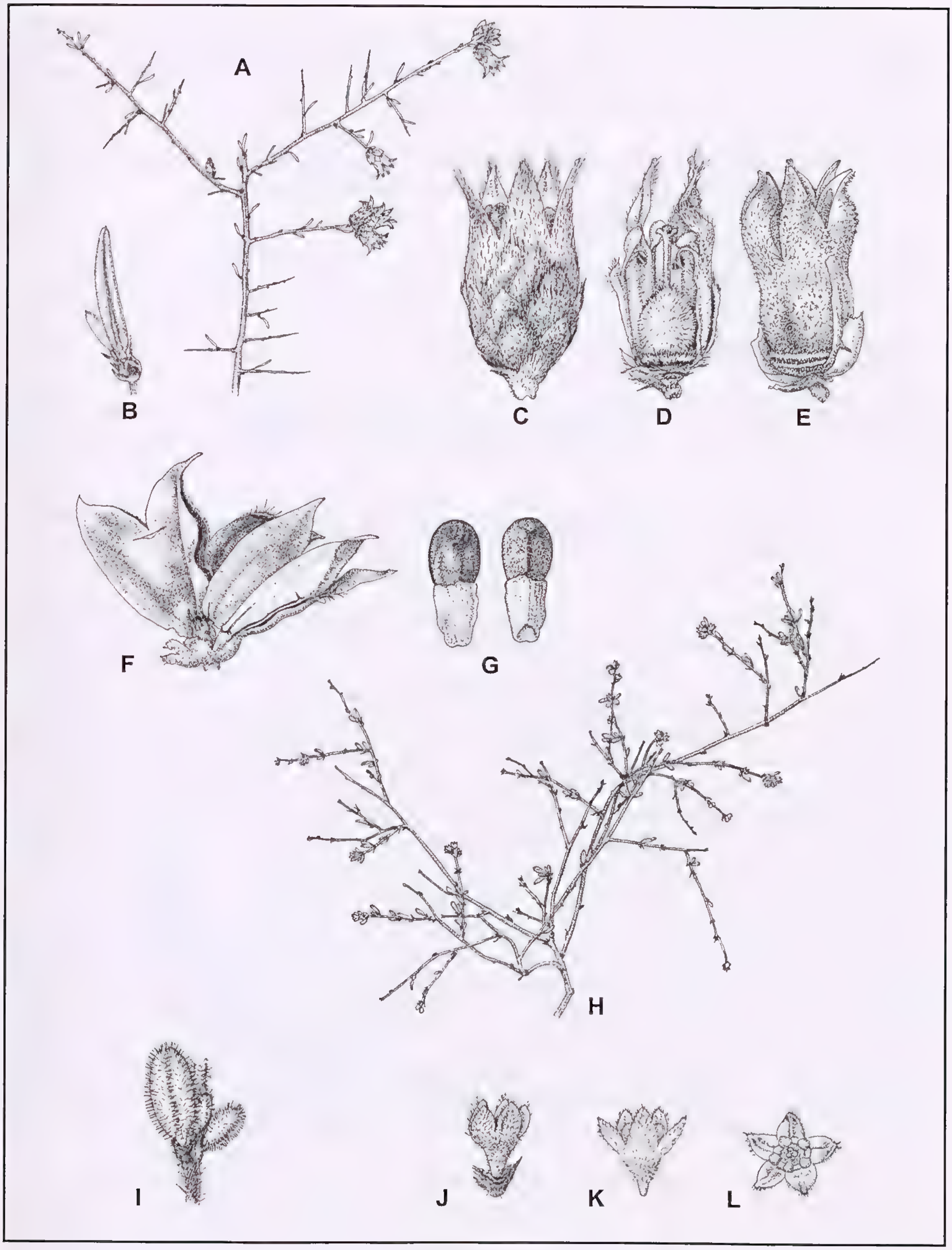

Figure 3. A–G. *Cryptandra imbricata*. A – flowering branch (×1), B – stipules and undersurface of leaf (×7), C – flower with bracts (×7), D – flower with part removed to show ovary and disc (×6), E – partially dehisced fruit (×6), F – fully dehisced fruit (×6), G – inner and outer surfaces of seed and aril (×6). H–L. *Cryptandra inconspicua*. H – flowering branch (×1), I – leaf cluster (×8), J – young flower and bracts (×8), K – flower and pedicel (×8), L – flower from top view (×8). Drawn from *A. Fairall* (A–C), *S. Pfeiffer s.n.* 1968 (D,E), *S.J. Patrick* 1885 (F,G) and *W.E. Blackall* 3049 (H–L).

of the fruit is concealed within the floral tube in *C. connata* and the sepals extend beyond the apex of the fruit, whereas in *C. imbricata* the fruit protrudes beyond the sepals. The limited records of flower colour on herbarium specimens also suggest that *C. connata* differs in having pink to red flowers, but possibly this colour does not develop until the fruiting stage.

Notes. One abnormality noticed among the *Cryptandra imbricata* specimens was that at least one of the flowers on *S.J. Patrick* 2263 had a 4-lobed stigma and 4-locular ovary.

Miscellaneous other species of *Cryptandra*

13. Cryptandra craigiae Rye, *sp. nov.*

Ramuli spinescentes pilis simplicibus; flores sessiles vel subsessiles bracteis c. 4 subtentis; floralis tubus parte libro infra 1 mm longo, pilis simplicibus; sepala pilis simplicibus; ovarium triloculare; stigma 3-lobatum.

Typus: NNE of Hopetoun [precise locality withheld], Western Australia, 13 May 2005, *G.F. Craig* 6438 (*holo:* PERTH 07129777; *iso:* MEL).

Shrubs erect at first, tending to become much more spreading, 0.1–0.25 m high, up to 0.35 m wide, single-stemmed at the base, not spinescent when young but with numerous spinescent branchlets at maturity. *Young stems* with a moderately dense to sparse indumentum of more or less appressed simple hairs 0.4–0.6 mm long; spinescent branchlets slender and often somewhat curved, mostly 10–25 mm long. *Stipules* 1.5–2.5 mm long, long-acuminate, ciliate, often hairy along midrib. *Petioles* protruding from the connate base of the stipule pair, 0.4–0.5 mm long, glabrous. *Leaf blades* linear in outline or very narrowly oblong, 4–5 × 0.6–0.8 mm, with recurved to revolute margins largely or completely concealing the lower surface; lower surface densely hairy but hairs often concealed; upper surface green, usually with denticulate to coarsely hair-like minute tubercles mainly towards apex; apical point 0.05–0.2 mm long. *Bracts c.* 4, ovate, *c.* 1.3 mm long, acute, ciliolate; outer surface glabrous or largely glabrous. *Flowers* in dense clusters 4–5 mm diam., usually 4–6 per cluster and one cluster terminating each branchlet, white or cream. *Floral tube c.* 1 mm long (enlarging in fruit), moderately densely hairy throughout but with indumentum tending to be more dense on adnate part; adnate part *c.* 0.4 mm long, green, with short stellate and simple hairs; free part 0.5–0.7 mm long, white or cream, with scattered simple antrorse to spreading hairs 0.4–0.5 mm long and more numerous very short simple hairs. *Sepals* 0.8–0.9 mm long, with simple hairs. *Petals c.* 0.6 mm long; claw *c.* 0.2 mm long. *Disc* densely stellate-hairy; hairs *c.* 0.2 mm long. *Ovary* 3-locular. *Style* 0.6–0.9 mm long; stigma 3-lobed. *Fruit* half-inferior, *c.* 2.5 mm long, densely minutely stellate-hairy on summit. *Seeds c.* 2 mm long; body *c.* 1.6 × 0.8 mm, with base very dark; aril *c.* 0.6 mm long, shortly 3-lobed.

Other specimens examined. WESTERN AUSTRALIA [precise localities withheld]: NNE of Hopetoun, early Oct. 2006, *J.A. Cochrane* 6031 (PERTH); NNE of Hopetoun, 10 May 2005, *G.F. Craig* 6408 (PERTH); NNE of Hopetoun, 13 May 2005, *G.F. Craig* 6425–6427 (PERTH); on Hopetoun–Ravensthorpe road, 2 June 2005, *G.F. Craig* 6474 (PERTH).

Distribution and habitat. Occurs near Hopetoun on the central south coast of the South West Botanical Province of Western Australia, mainly on low-lying sand dunes, on low rises between or adjacent to swampy areas, also recorded from a gutter on a disturbed road verge. (Figure 2A)

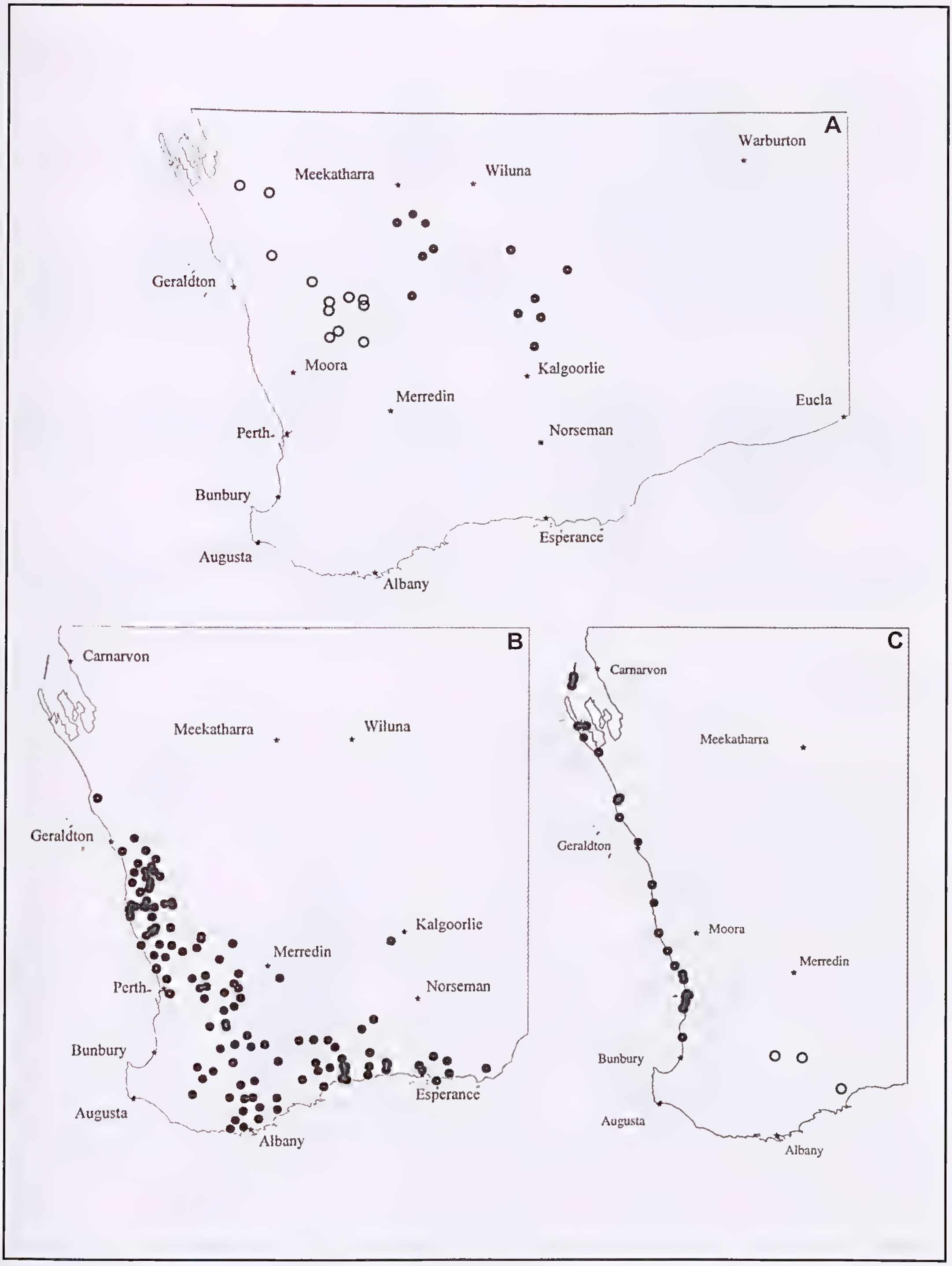

Figure 4. Geographic distributions of south-western Australian species. A – *Cryptandra connata* ● and *Cryptandra imbricata* ○; B – *Cryptandra pungens*; C – *Cryptandra inconspicua* ○ and *C. mutila* ●.

Flowering period. May to June.

Conservation status. Conservation Codes for Western Australian Flora: Priority One. This species is known from just two populations *c.* 1 km apart.

Etymology. Named in honour of Gillian Craig, a consultant botanist who discovered this species and has made almost all of the known collections of it so far.

Affinities. The affinities of this species are unclear, but it might be closest to *Cryptandra scoparia* Reissek. It can be distinguished from *C. scoparia* by its more hairy floral tube but, as in that species, the hairs are all simple. The lack of stellate hairs on its stems and floral tube distinguishes *C. craigiae* from most members of its genus.

Notes. Previously known as *Cryptandra* sp. Hopetoun (*G.F. Craig* 6408). Gill Craig (pers. comm.) observed that seedlings lack the spinescent branchlets of the mature plants of this new species. This might explain some of the variation observed on specimens of several taxa, such as *C. mutila*, which appear to be unarmed in some collections and spinescent in others.

In the single fruiting specimen examined, which was collected in early October, the fruits appeared to be barely mature and the seeds were extremely pale except for a very dark base so the mature colouring of the seeds is still not certain.

14. **Cryptandra dielsii** C.A. Gardner ex Rye, *sp. nov.*

Cryptandrae polycladae simile sed apice foliorum manifeste recurvo, inflorescentia magis pilosa, bracteis involucralibus in quoque florem cingentibus differt.

Typus: Tammin, Western Australia, 1 September 1936, *C.A. Gardner s.n.* (*holo:* PERTH 01529722: *iso:* CANB, PERTH 01503804).

Shrubs spreading, 0.3–0.7 m high, intricately branched. *Branchlets* not spinescent. *Young stems* with a dense fine tangled indumentum; hairs appressed to patent, all or at least the larger ones apparently simple, the largest hairs 0.5–1 mm long. *Stipules* shortly connate at base to the outside of petiole, overlapping at the base to inside of the leaf, 1.7–2.3 mm long, long-acuminate, with cilia *c.* 0.3 mm long; outer surface usually with scattered hairs especially along the midvein. *Petioles* usually concealed by the connate base of the stipule pair, *c.* 0.2 mm long. *Leaf blades* linear to narrowly oblong, 2–5 × 0.6–0.8 mm, with recurved to revolute margins concealing the lower surface, the apex recurved, with a prominent mucro 0.1–0.3 mm long; lower surface hairy but hairs concealed except occasionally for a few protruding from the line where the recurved margins meet; upper surface smooth or with minute broad protrusions. *Inflorescence* very dense, head-like, 4–8 mm wide, mostly 6–9-flowered, the individual flowers not distinct, surrounded by large involucral bracts. *Involucral bracts* largely chartaceous but with a reduced leaf blade at summit. *Floral bracts* 2–4 per flower, usually 3 with the outer bract larger than the other two, mostly broadly elliptic, 1.8–3.5 mm long, apiculate to acuminate, hairy along the midvein, prominently ciliate acoss the broad summit, which is often toothed and/or emarginate, the cilia 0.3–0.7 mm long. *Flowers* white. *Involucral tube* 1.5–2 mm long (not seen in fruit), minutely stellate-hairy and with simple tangled antrorse hairs 0.8–1.3 mm long; adnate part of tube 0.7–1 mm long; free part of tube 0.8–1 mm long. *Sepals* 0.7–1.3 mm long, with a very dense

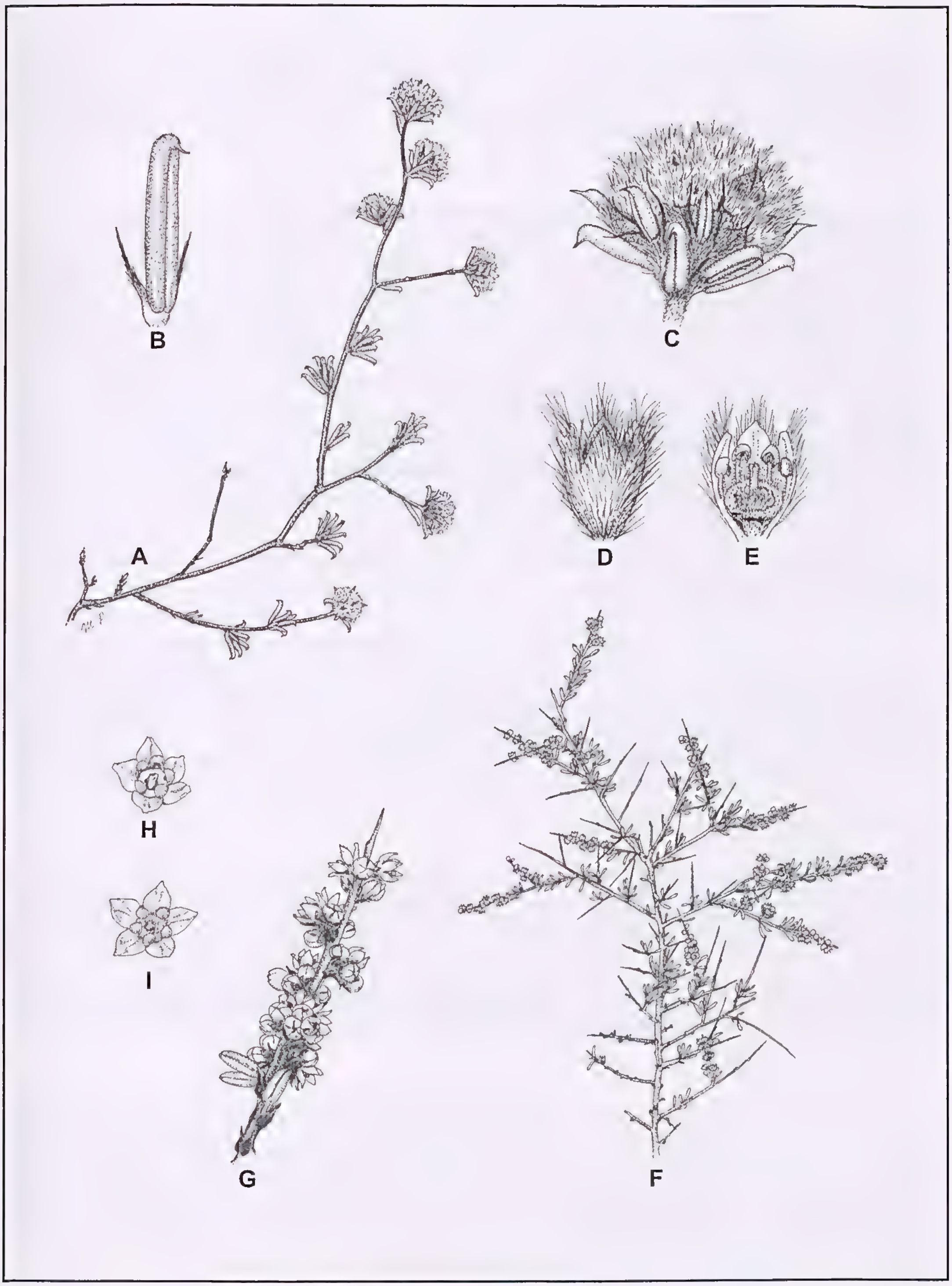

Figure 5. A–E. *Cryptandra dielsii*. A – flowering branch (×1), B – stipules and undersurface of leaf (×6), C – flower cluster (×4), D – flower (×6), E – flower dissected open (×6); F–I. *Cryptandra micrantha*. F – flowering branch (×1), G – spinescent flowering branchlet (×5), H – flower with glabrous disc (×15), I – flower with hairy disc (×15). Drawn from *B.H. Smith* 395 (A–E), *K.F. Kenneally* 1836 (F–H) and *H. Demarz* 3808 (I).

indumentum of spreading and tangled simple hairs 0.8–1.5 mm long. *Petals* 0.5–0.6 mm long; claw 0.1–0.2 mm long. *Disc* densely stellate-hairy; hairs *c.* 0.2 mm long. *Ovary* 3-locular; summit with hairs *c.* 0.3 mm long. *Style* 0.8–1.3 mm long, with minute papillae; stigma 3-lobed. *Fruit c.* two-thirds inferior, concealed within the floral tube, *c.* 2 mm long, stellate-hairy on summit. *Seeds c.* 1.6 mm long; body *c.* 1.35 × 0.8 mm, much compressed, base very dark, pale brown above; aril *c.* 0.5 mm long, whitish-translucent, 3-lobed. (Figure 5A–E)

Other specimens examined. WESTERN AUSTRALIA: Durokoppin Nature Reserve, 18 Sep. 1996, *L. Atkins* 187 (PERTH); Tammin, 4 Sep. 1922, *C.A. Gardner* 689 (PERTH); Tammin, May 1927, *C.A. Gardner s.n.* (PERTH); 18 km SE of Holt Rock, 17 Sep. 1976, *R. Hnatiuk* 760814 (PERTH); Kellerberrin–Yelbeni road, 0.6 km N of Yorkrakine Rock Rd, 23 Aug. 2000, *S.J. Patrick* 3743 *& L. Polomka* (PERTH); E edge of Durokoppin Nature Reserve, *c.* 20 m from W edge of Mission Rd, 0.8 km S of Brown Rd, 23 Aug. 2000, *S.J. Patrick* 3751 *& L. Polomka* (PERTH); Durokoppin Nature Reserve, N–S firetrack, 1.9 km S of Brown Rd, 24 Aug. 2000, *S.J. Patrick* 3755 *& L. Polomka* (PERTH); Durokoppin Nature Reserve, S side of main E–W firetrack through middle of reserve, *c.* 50 m E of Bencubbin–Kellerberrin road, 24 Aug. 2000, *S.J. Patrick* 3754 *& L. Polomka* (PERTH); NE corner of block loc. 19405, N side of Manmanning Rd, SW of Manmanning, 23 July 2001, *S.J. Patrick* 3921 *& L. Polomka* (PERTH); 27.3 km *c.* NE from Narembeen on Narembeen–Muntadgin road, 16 Oct. 1975, *G. Perry* 522 (PERTH); 2 km SW of Manmanning, 28 Aug. 1978, *B. & M. Smith s.n.* (PERTH); Durokoppin, 4 Sep. 1996, *B. H. Smith* 1862 (PERTH); 1 mile [1.6 km] SW of Manmanning, 29 July 1984, *B.H. Smith* 395 (PERTH).

Distribution and habitat. Endemic to the South West Botanical Province of Western Australia. Extends from Manmanning south-east to near Varley, north of Lake King. The Varley collection is separated by a disjunction of about 130 km from the other collections, the closest of which is near Muntadgin. Often occurs in sandy soils over laterite but some records give the soil type as clay or loam, the vegetation commonly dominated by *Allocasuarina campestris*. (Figure 2A)

Flowering period. July to September.

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. Although its range is at least 300 km, this species is only known from a few localities in the central wheatbelt, an area that has been largely cleared.

Etymology. Named after F.L.E. Diels, a prominent botanist from Berlin, whose considerable contribution to Western Australian botany included the description of a number of new taxa in the Rhamnaceae (in Diels & Pritzel 1904).

Affinities. This extremely distinctive species has no very close relatives. The species with which it is most likely to be confused are *Cryptandra polyclada* and *C. spyridioides*, which overlap in range with it in Western Australia. The latter is readily distinguished by its 2-locular ovary and 2-lobed stigma. *Cryptandra polyclada* has a similar general appearance but differs in many respects including its shorter stipules, blunter and more erect leaf apex and less hairy flowers with more numerous floral bracts. *Cryptandra intonsa* has stipules and leaves of a similar shape to those of *C. dielsii* but is very different in other respects, for example in its much larger flowers.

Notes. This species was housed at PERTH as *Cryptandra dielsii* C.A. Gardner ms. until 1991 when the phrase name *Cryptandra* sp. Manmanning (*B.H. Smith* 395) was applied, and this was followed by the use of the name *Stenanthemum dielsii* ms. in 1994. Confusion regarding the correct generic placement of *C. dielsii* resulted from its compact inflorescence surrounded by involucral bracts that superficially resemble those of some *Stenanthemum* species, particularly *S. humile* Benth. and *S. pumilum*. *Cryptandra dielsii* shows other parallels with those two species in having flowers with a long floral tube and conspicuously hairy sepals, but these characters may also be found in *Cryptandra* species such as *C. leucopogon*.

The involucral bracts in *C. dielsii* are formed from stipules modified into much enlarged structures connate for a long distance and with a reduced leaf borne at the summit. This is evidently a modification of the typical *Cryptandra* stipules, which are shortly connate to form a slight or definite lip to the outside of the leaf petiole but free to the inside of the leaf. In contrast in *Stenanthemum* the stipules are free to the outside of the leaf but are often connate for some distance to the inside of the leaf, so involucral bracts modified from these have the leaf borne at the base of the long-connate stipules as in *S. pumilum* and *S. humile*. Most species of *Stenanthemum*, however, have the involucral bracts further modified to resemble the floral bracts, without any obvious division into stipule and leaf components. Some *Spyridium* species such as *S. microcephalum* (Turcz.) Benth. tend to have the outer bracts more closely resembling those of *C. dielsii*, but differing in having the enlarged bases of the stipules separated by a hairy petiole-like structure with the reduced leaf borne at its summit.

Although atypical of *Cryptandra* in its inflorescence and prominent involucral bracts, *C. dielsii* appears to be typical of the genus in all other respects and is atypical of *Stenanthemum* in its stipules, leaves, disc and seed colouring. Molecular data (Kellermann *et al.* 2005) strongly support its placement in *Cryptandra* together with all species that have a hairy disc and stipules united outside the petioles. Its head-like inflorescence surrounded by involucral bracts could be a further modification from the head-like flower clusters in species such as *C. polyclada* and *C. spyridioides*, in which there are clearly a number of the uni-flowered multi-bracteate inflorescence units that are typical of *Cryptandra*. In *C. polyclada* the leaves and their associated stipules are arranged around each flower 'head' in the position of the involucral bracts of *C. dielsii* but are not modified, i.e. they are of the same form as the vegetative leaves and stipules.

However, in *Cryptandra dielsii*, each flower is usually subtended by one large bract and two small lateral bracts, probably representing the remnants of cymes and similar to those in many other genera such as *Spyridium* and *Stenanthemum*, so could represent the primitive arrangement of the flowers in *Cryptandra* prior to the development of the many-bracted flowers that typify *Cryptandra* (K. Thiele pers. comm.). On this basis, it could have closer affinities with the few other species that lack the typical *Cryptandra* inflorescence, i.e. with the *C. pungens* group or with the *C. intratropica* group.

15. **Cryptandra exserta** Rye, *sp. nov.*

Cryptandrae minutifoliae affinis sed foliorum puncto apicali magis erecto et floribus e bracteis involucralibus magis exsertis differt.

Typus: 0.5 km S of rail crossing, 41.5 km S of Norseman Post Office on Coolgardie–Esperance highway, Western Australia, 29 July 2001, *B. Archer* 1940 (*holo:* PERTH 06144411; *iso:* CANB, MEL, NSW all *n.v.*).

Shrubs c. 0.5 m high. *Branchlets* not obviously spinescent. *Young stems* with a dense matted indumentum at first of long very fine hairs, the individual hairs too tangled for their type (whether simple or stellate) to be readily determined but both stellate hairs and simple present, becoming glabrous. *Stipules* 0.6–1 mm long, acute to acuminate, ciliate. *Petioles c.* 0.3 mm long. *Leaf blades* narrowly oblong, 2.3–2.5 × 0.5–0.7 mm, with recurved to revolute margins completely or almost completely concealing the lower surface, tending to have acute tubercles on upper surface, lower surface white-hairy; mucro fairly erect, up to 0.2 mm long. *Bracts c.* 10, broadly ovate to oblong-elliptic, inner surface of outer bracts with long hairs along midvein; inner bracts c. 1.5 mm long, obtuse, densely ciliate; outer surface largely glabrous, with a few scattered minute stellate hairs towards the centre. *Flowers* usually 2–5 per branchlet in a terminal cluster, sometimes up to 10 in a spike-like group, white. *Floral tube* c. 2.5 mm long; adnate part of tube c. 0.5 mm long, densely minutely stellate-hairy, with a few long simple hairs towards the top; free part c. 2 mm long, rather densely hairy in distal half, becoming more sparsely hairy below, with a mixture of minute stellate hairs and longer simple hairs. *Sepals* 2–2.5 mm long, densely hairy with stellate and simple hairs, the latter hairs 0.4–0.6 mm long. *Petals c.* 1 mm long; claw *c.* 0.2 mm long. *Disc* with stellate hairs *c.* 0.3 mm long. *Ovary* 3-locular; summit with stellate hairs c. 0.35 mm long. *Style* 2–2.2 mm long, extreme base with stellate hairs; stigma 3-lobed. *Fruit* concealed within the floral tube, half-inferior, *c.* 3 mm long, densely minutely stellate-hairy on summit. *Seeds c.* 2.5 mm long, with a body *c.* 2 mm long and a 3-lobed aril *c.* 0.7 mm long.

Other specimen examined. WESTERN AUSTRALIA: in the SW corner of track junction of gridline and Mt Gibbs track, *c.* 900 m SSE of Hatter Hill, 4 Sep. 1996, *N. Gibson & K. Brown* 2983 (PERTH).

Distribution and habitat. Distributed close to, and on both sides of, the border between the South West Botanical Province and the South Western Interzone of Western Australia in the region from Hatter Hill east to between Norseman and Kumarl. One record is from sandy soil with lateritic gravel and rocks in mallee-dominated vegetation, while the other record is from red sand over clay in vegetation with *Acacia*, *Allocasuarina* and *Santalum*. (Figure 6A)

Flowering period. July to September.

Conservation status. Conservation Codes for Western Australian Flora: Priority One. The distance between the two known localities of this taxon is *c.* 160 km. The area is poorly known botanically; with further survey more populations of *C. exserta* are likely to be found.

Etymology. From the Latin word *exsertus* – protruding, as the flowers protrude far out of the involucre of bracts.

Affinities. This taxon is either part of or closely related to the *Cryptandra minutifolia* complex. It has some of the characteristics of *C. wilsonii* Rye, differing in its petioles tending to be hidden within the stipule pair and its larger flowers, suggesting the possibility that it is of hybrid origin between the *C. minutifolia* complex and *C. wilsonii*.

Notes. Previously housed at PERTH as *Cryptandra* sp. Norseman (*B. Archer* 1940), this species is very poorly known. The description of the fruit is based on a single old fruit with one seed inside. Better fruiting collections are needed.

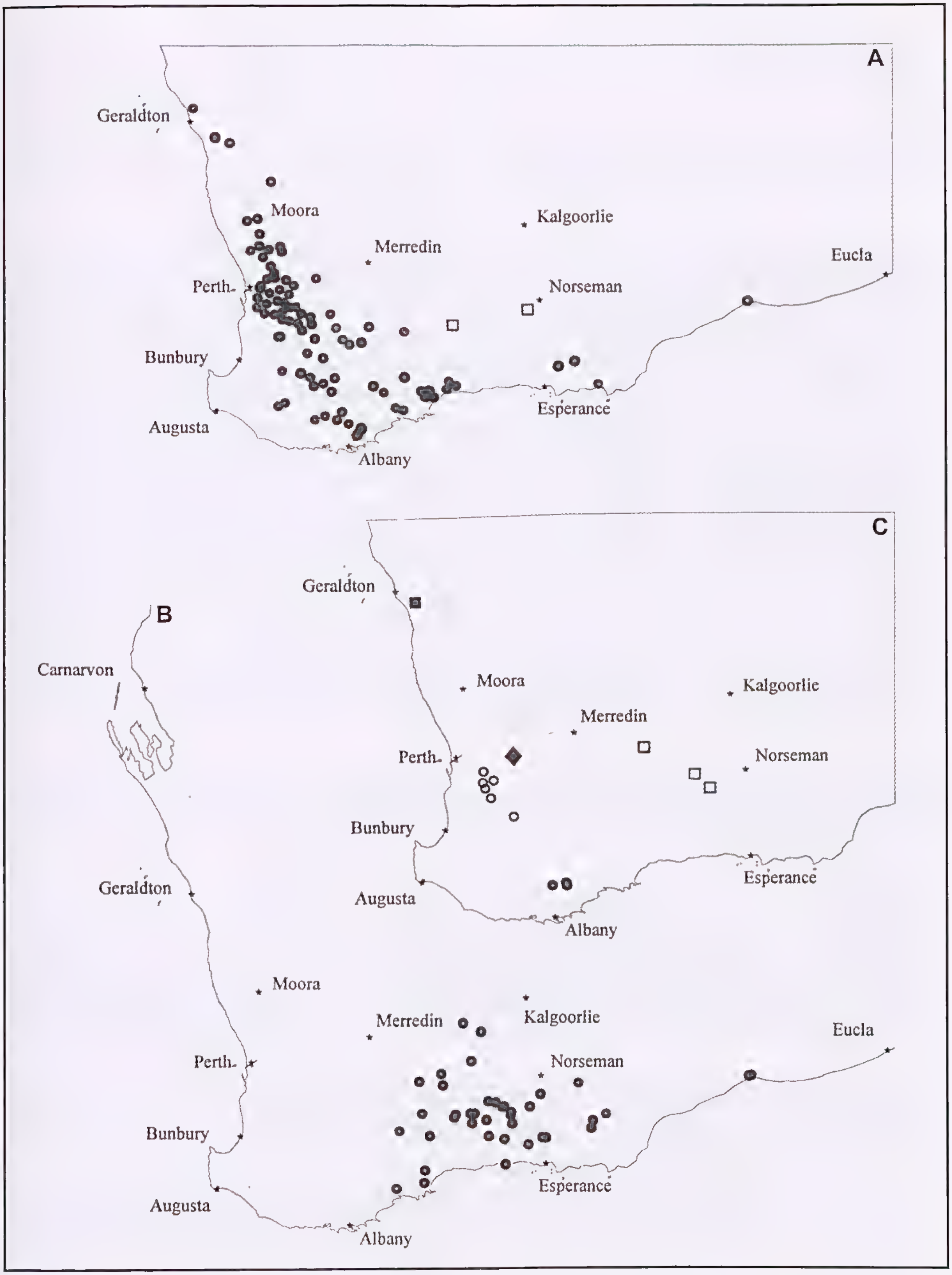

Figure 6. Geographic distributions. A – *Cryptandra nutans* Steud. ● and *C. exserta* □; B – *Cryptandra recurva* Rye; C – *Stenanthemum bremerense* □, *S. pumilum* subsp. *majus* ○, *S. pumilum* subsp. *pumilum* ●, *S. radiatum* □ and *S. yorkense* ♦.

16. **Cryptandra inconspicua** Rye, *sp. nov.*

Cryptandrae pungens affine sed ramulis non spinescentibus, pedicellis brevioribus, disco glabro differt.

Typus: Between Pingrup and Lake Grace, Western Australia, 21 September 1933, *W.E. Blackall* 3049 (*holo:* PERTH 01516418; *iso:* CANB, MEL, PERTH 01516426).

Shrub spreading, sometimes semi-prostrate, 0.1–0.2 m high. *Branchlets* not spinescent. *Young stems* with simple patent hairs 0.1–0.25 mm long. *Stipules* 0.7–1.5 mm long, acute to long-acuminate, usually with a few hairs scattered along midvein and a few cilia. *Petioles* 0.3–0.4 mm long. *Leaf blades* narrowly elliptic to obovate, 2–3.7 × 0.7–1.5 mm, usually obtuse; lower surface often concealed by leaf margins, densely hairy; upper surface with simple patent hairs 0.1–0.2 mm long. *Bracts* 2–4 per flower, ovate, 0.5–0.7 mm long, acute, prominently ciliate, the largest cilia *c.* 0.2 mm long; outer surface often hairy along the midvein or sparsely hairy in distal half. *Pedicels c.* 0.4 mm long. *Flowers* usually 3–8 per branchlet, in a head-like cluster 2–3.5 mm wide, white. *Floral tube c.* 0.9 mm long (not seen in fruit), with stellate hairs and simple hairs of a similar size to those on the sepals; adnate part of tube *c.* 0.5 mm long, very densely hairy; free part of tube *c.* 0.4 mm long, moderately densely hairy. *Sepals* 0.5–0.6 mm long, moderately densely hairy with stellate and simple hairs 0.1–0.2 mm long. *Petals c.* 0.3 mm long; claw *c.* 0.1 mm long. *Disc* glabrous. *Ovary* 3-locular; summit with hairs *c.* 0.2 mm long. *Style* 0.3–0.4 mm long; stigma 3-lobed. *Fruit* unknown. (Figure 3H–L)

Other specimens examined. WESTERN AUSTRALIA: no locality or date, *Anon.* Herb. C.A. Gardner 1743 (PERTH); Wishbone, Sep. 1926, *C.A. Gardner & W.E. Blackall s.n.* (PERTH); near junction of Fitzgerald River National Park and Susetta River, 13 July 1970, *A.S. George s.n.* (PERTH).

Distribution and habitat. Endemic to the South West Botanical Province of Western Australia, recorded from Wishbone (near Dumbleyung), from between Pingrup and Lake Grace and from Fitzgerald River National Park. Habitat unknown. (Figure 4C)

Flowering period. July to October.

Conservation status. Conservation Codes for Western Australian Flora: Priority Two. There are four collections recorded from localities over a range of *c.* 170 km. The most recent collection, made in 1970, is from a large national park. As this species is relatively inconspicuous, it may prove to be poorly collected rather than genuinely rare, but the lack of recent collections is a concern.

Etymology. From the Latin *inconspicuus* – not readily visible, referring to the likelihood of these small plants, with their tiny leaves and flowers, being overlooked.

Affinities. This new species apparently belongs to the small group of species that would be placed in subg. *Corisandra* if that group were still recognised. It is like *Cryptandra mutila* and *C. pungens* in its few floral bracts and inflorescence type, but those two species have longer, more obvious pedicels and a hairy disc. *Cryptandra mutila* also differs in having glabrous flowers, and usually has a bilocular ovary and two stigmatic lobes, while *C. pungens* differs in having spinescent branchlets.

Notes. Fruiting material of the new species is needed to complete the description of this poorly known species.

17. Cryptandra micrantha Rye, *sp. nov.*

Ramuli spinescenti; flores sessiles vel subsessiles, minuti, plerumque perfecte glabri; ovarium uniloculare; stigma integrum; fructus magnopere inferiore.

Typus: 700 m north-east of Mt Gibson, Western Australia, 15 July 1994, *S.J. Patrick* 1855 (*holo:* PERTH 04159950; *iso:* CANB).

Shrubs rounded or low and spreading, commonly 0.3–0.6 m high. *Branchlets* spinescent. *Young stems* with simple appressed hairs or glabrous, the longer hairs 0.5–0.6 mm long. *Stipules* 0.6–1.3 mm long, acute to long-acuminate, ciliate. *Petioles* protruding from the connate base of the stipule pair, 0.3–0.4 mm long, glabrous. *Leaf blades* narrowly oblong to elliptic, 1.3–2.3 × 0.4–0.7 mm, entire, with recurved to revolute margins partially to completely concealing the lower surface, usually obtuse; lower surface glabrous to densely hairy but hairs often concealed; upper surface glabrous, green. *Bracts* 4–6, ovate, 0.4–0.8 mm long, acute, ciliate, the cilia 0.1–0.15 mm long; outer surface often hairy along the midvein. *Flowers* few to numerous per branchlet in several dense clusters 1.5–3 mm wide, white or cream. *Floral tube* 0.8–1.0 mm long (enlarging to 1.7–2.2 mm in fruit); adnate part of tube *c.* 0.5 mm long, glabrous throughout or rarely with a few stellate hairs *c.* 0.1 m long; free part of tube 0.3–0.45 mm long, glabrous. *Sepals* 0.6–0.7 mm long, glabrous. *Petals* 0.4–0.5 mm long; claw *c.* 0.1 mm long. *Disc* densely stellate-hairy or glabrous; hairs 0.1–0.2 mm long. *Ovary* 1-locular. *Style* *c.* 0.25 mm long; stigma not lobed. *Fruit* apparently indehiscent, largely inferior (*c.* three-quarters inferior), *c.* 2.0 × 1.2 mm; superior part enclosed by free floral tube and sepals, sparsely stellate-hairy on summit, the disc forming a very prominent, usually densely stellate-hairy rim around the sparsely stellate-hairy summit. *Seeds* *c.* 1.4 × 1 mm, much compressed, base colour not recorded, medium brown above; aril very reduced, scarcely lobed. (Figure 5F–I)

Selected specimens examined. WESTERN AUSTRALIA: 8 miles [13 km] N of Wialki, 16 July 1967, *J.S. Beard* 4722 (PERTH); Blue Hills, Karara Station, 29°09'S, 116°53'E, 21 Oct. 2003, *E.M. Bennett* *s.n.* (PERTH); Mt Gibson, *c.* 1 km NE of homestead, 3 June 1984, *D.G. Fell* 0213 (PERTH); near Jibberding, 9 July 1931, *C.A. Gardner & W.E. Blackall* 20 (PERTH); Fowlers Gully, Wongan Hills, 20 July 1974, *K.F. Kenneally* 1836 (PERTH); Mt Singleton, 24 Aug. 1965, *K.R. Newbey* 2012 (PERTH); 20 km W of Boorabbin, 26 July 1981, *K.R. Newbey* 8363 (PERTH); 8.3 km NNE of landing ground on Warriedar Coppermine road, 17 July 1994, *S.J. Patrick* 1881 (PERTH); 17 km SE of Tardun, 22 July 1994, *S.J. Patrick* 1912, 1913 (PERTH); 5 km SW of Paynes Find, 24 June 1995, *S.J. Patrick* 2291 (PERTH); Mt Singleton, 21 Aug. 1985, *B.H. Smith* 615 (PERTH); Mt Singleton, 6 Aug. 1969, *P.G. Wilson* 8617 (PERTH).

Distribution and habitat. Endemic to the south-west of Western Australia. Extends from near Canna south to Wongan Hills in the South West Botanical Province, south-west to near Boorabbin South Western Interzone and east to Kirkalocka Station (south of Mount Magnet) in the Eremaean Botanical Province. Recorded from stony sites with red or brown clayey soil and from deep yellow sand. Commonly occurs in hilly areas with rock substrates of volcanic origin, and also known from granitic and lateritic sites. (Figure 2C)

Flowering period. July to August.

Conservation status. Known from about ten localities over a range of *c.* 370 km, including a national park. The species was abundant at three northern populations surveyed in 1992–1994 by Sue Patrick (pers. comm.).

Etymology. From the Greek *mikros* – small and *anthos* – flower, as this species has the smallest flowers in its genus.

Affinities. This species is very distinctive and does not appear to have any close relatives. Its normally 1-ovulate unilocular ovary is unique in *Cryptandra* and unknown in all other south-western Australian genera of Rhamnaceae, although one species of *Trymalium* that has a 3-locular ovary aborts two loculi as the fruit develops and so is like *C. micrantha* in producing a unilocular 1-seeded fruit (Rye 2000). Most species of *Cryptandra* have a 3-locular ovary, but there are four species that are usually or always 2-locular. These 2-locular species all appear to have close relatives that are 3-locular and show no close relationship to the unilocular *C. micrantha*, so it appears that, several independent lineages showing reduction in the number of ovary chambers have occurred within the genus *Cryptandra*.

The one-chambered fruit of *C. micrantha* has not been seen at maturity but appears to be indehiscent or at least shed intact, with the casing soft and flexible rather than brittle. There is usually a solitary seed, but one 2-seeded fruit has been observed. *Cryptandra micrantha* has an exceptionally small aril on the very compressed seed body, the aril slightly lobed but not obviously 3-lobed as in most *Cryptandra* species, which have a moderately large aril. The reduced aril resembles that of *Spyridium* and *Trymalium* species, which have indehiscent fruitlets and therefore do not rely on the aril for their dispersal.

Notes. Cryptandra micrantha is a quite variable species. Two specimens collected from Wongan Hills are unusual in having a glabrous disc (Figure 6I). They are not unique in this respect, however, as there is also a specimen from near Tardun with the disc glabrous (J. Kellermann pers. comm.). There is also considerable variation elsewhere, for example with northern specimens of *C. micrantha* tending to have glabrous stems and leaves. Flowers are occasionally 4-merous.

18. Cryptandra multispina Rye, *nom et stat. nov.*

Cryptandra scoparia var. *microcephala* Benth., Fl. Austral. 1: 439 (1863). *Type:* Murchison River, Western Australia, *A. Oldfield s.n.* (*holo:* K, *n.v.*, scan seen; *iso:* MEL 227043).

Illustration. Rye (1995b: fig. 5K–N).

Selected specimens examined. WESTERN AUSTRALIA: 1.9 km N of Greenough River on W (central) boundary of East Yuna Nature Reserve, 15 Nov. 1997, *P.G. Armstrong s.n.* (PERTH); Kalbarri National Park, 100 m S of crossroads on E side of firebreak, 12 km E of South Dam, 6 Sep. 1990, *A.H. Burbidge* 4359 (PERTH); Cooloomia Nature Reserve, 3 Aug. 1996, *G.J. Keighery & N. Gibson* 2069 (PERTH); on E side of railway line, 2.3 km S of Garranya Rd, Marchagee Nature Reserve, 17 Apr. 2000, *G.J. Keighery & N. Gibson* 5029 (PERTH); between Moore and Murchison Rivers, June 1901, *E. Pritzel* 377 (PERTH).

Distribution and habitat. Occurs in the north of the South West Botanical Province of Western Australia, extending from near Shark Bay south-east to Marchagee. (Figure 7B)

Flowering period. June to September.

Etymology. From the Latin *multi* – many and *spina* – thorn, referring to the numerous spinescent branchlets occurring along the young stems of this species.

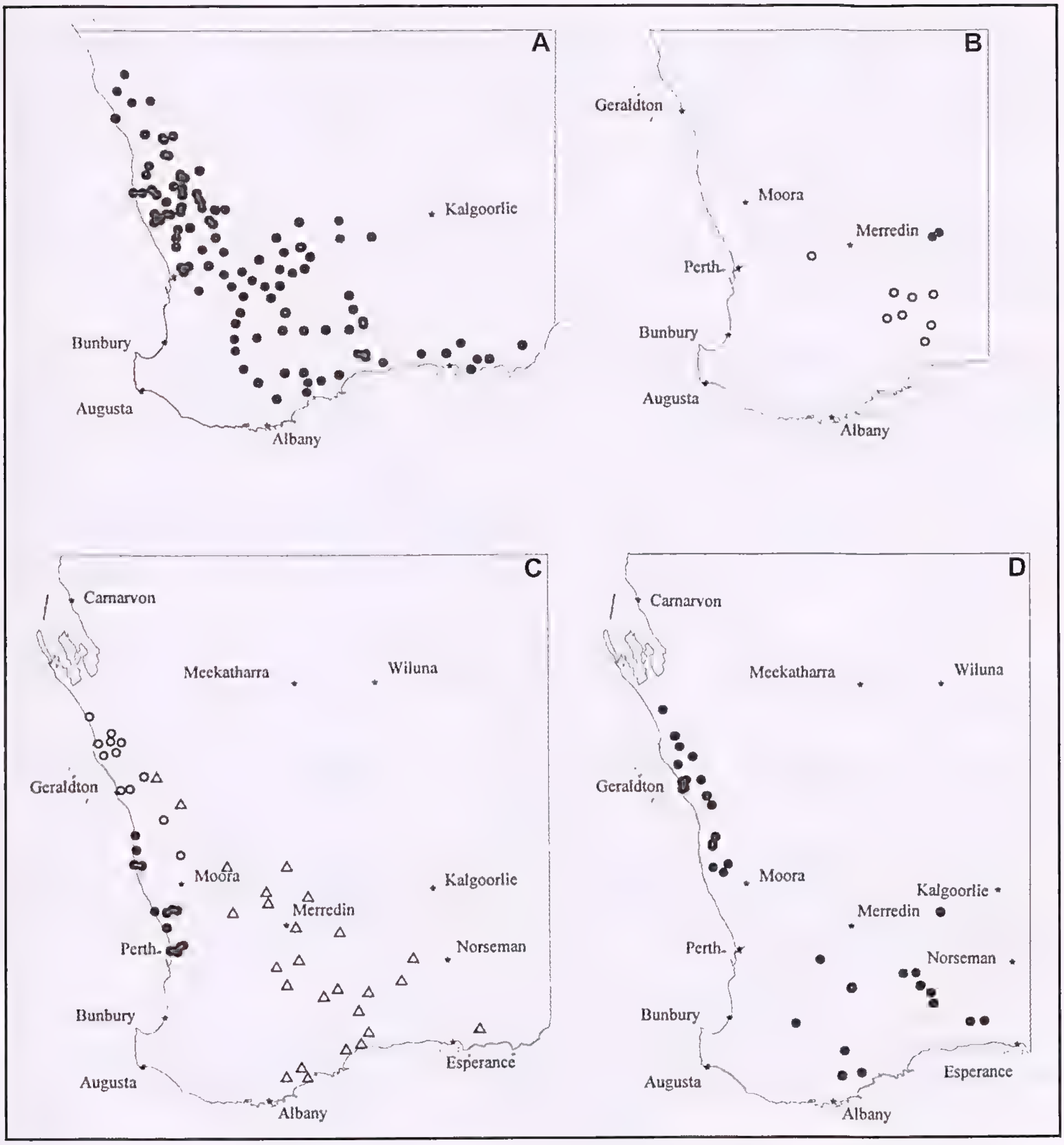

Figure 7. Geographic distributions. A – *C. myriantha* Diels; B – *Cryptandra polyclada* subsp. *aequabilis* Rye ● and *C. polyclada* Diels subsp. *polyclada* ○; C – *Cryptandra multispina* ○, *C. scoparia* ● and *C. wilsonii* Rye △ ; D – *C. spyridioides* F. Muell.

Conservation status. Once classed as a Priority Two taxon, this species is now better collected over a much wider range and is no longer considered to be at risk.

Affinities. Quite clearly the closest relative of this taxon is *Cryptandra scoparia*, but there are significant vegetative differences and also minor floral differences between the two species.

Cryptandra multispina is one of the few Western Australian members of the genus to be consistently spinescent. Its young stems have numerous and fairly equidistant lateral spinescent branchlets. On young stems these spinescent branchlets are only 5–7 mm long and have a maximum of one node, but on lower stems they may become somewhat longer and have more than one node. In contrast

Cryptandra scoparia lacks spinescence in some specimens and is often less consistent when spinescent lateral branchlets are present. Its spinescent branchlets are longer than in *C. multispina* and have 1–4 nodes. There is also a difference between the two taxa in their young bark as *C. multispina* has pale glabrous or glabrescent bark peeling in broad strips from the young stems whereas *C. scoparia* has hairy dark bark remaining attached for longer and then peeling in narrow strips and patches.

In *Cryptandra scoparia* the petioles tend to be hidden by the stipules or only shortly exserted whereas, in *C. multispina*, the petioles are very obvious and always well exserted from the stipules. Leaf blades tend to be longer in *C. scoparia* and they are sometimes hairy whereas they are consistently glabrous in *C. multispina*.

Differences in the floral morphology of the two taxa are less obvious but the sepals tend to have coarser hairs forming more obvious apical tufts in *C. multispina* than in *C. scoparia*.

Notes. This species has been known by the informal name *Cryptandra* sp. Kalbarri (*A.S. George* 2364), although it has more commonly been regarded as a variety of *C. scoparia*. A new name is required for the taxon, rather than just a recombination, as the varietal epithet has already been used at the species level in the name *Cryptandra microcephala* Turcz. , which is the basionym for *Spyridium microcephalum* (Turcz.) Benth.

18. Cryptandra mutila Nees ex Reissek *in* J.G.C. Lehmann, Pl. Preiss. 2: 289–290 (1848). *Type:* Woodman Point, Perth, Western Australia, 17 August 1839, *L. Preiss* 1229 (*syn:* LD).

Selected specimens examined. WESTERN AUSTRALIA: E of Hutt River estuary, Lynton Station, Port Gregory, 1999, *J. Brooker* L58 (PERTH); Sep. 1903, *W.V. Fitzgerald s.n.* (PERTH ex NSW).

Notes. Of particular interest is an old collection (*W.V. Fitzgerald* Sep. 1903) that has evidence of adventitious roots and multiple shoots along a horizontal underground stem. This unusual habit may be related to the coastal distribution of *Cryptandra mutila*, as many coastal taxa are adapted to cope with shifting sand dunes.

Most specimens of *Cryptandra mutila* have all or most of their flowers with a 2-locular ovary and a 2-lobed stigma. Occasional specimens with mostly 3-locular ovaries are now known, one of which was briefly housed under the phrase name *Cryptandra* sp. Port Gregory (J. Brooker L58).

Stenanthemum Reissek

For synonyms, a description of this genus and distribution maps of most species see Rye (2001).

Size and distribution. A genus of at least 30 species, occurring mainly in central and southern Australia, particularly in Western Australia where there are 26 species currently recognised, but also represented by one species in northern Queensland. A key to the species of *Stenanthemum* occurring outside Western Australian is given in Thiele (2007). The Western Australian species are endemic except for *S. notiale*, which also occurs in South Australia and Victoria, and *S. petraeum*, which extends into Northern Territory.

As noted earlier, the presence of a thick annular disc in *Stenanthemum sublineare* distinguishes this species from the remainder of the species of *Stenanthemum* and its generic placement has therefore been questioned. However, a preliminary ITS sequence analysis indicates that this species does belong in *Stenanthemum* and that it is closely related to *S. humile* and *S. reissekii* Rye (J. Kellermann pers comm.). Further molecular sequencing will be carried out to test this placement. Recent collections of *Stenanthemum sublineare* have extended its range down the west coast to Augusta and along the south coast to the Manypeaks area. Southern collections show some morphological differences which suggest that they need to be recognised formally, probably at the subspecific level, but this will be dealt with in a separate paper.

Key to Western Australian species and subspecies of *Stenanthemum*

To accommodate the new taxa, five new pairs of couplets have been added to the key to species given previously (Rye 2001) for *Stenanthemum*. A couplet has also been removed to delete the anomalous species *Stenanthemum sublineare*, which is keyed separately in the generic key.

1. Floral tube (in flower) 0.6–1.3 mm long; free part 0.3–0.8 mm long, shorter than or about as long as the sepals

  2. Stipules free or connate for less than a quarter of their length

    3. Leaves with prominently recurved margins

      4. Leaves prominently 2-lobed at apex; upper surface densely hairy. Bracts whitish. Floral tube *c.* 0.7 mm long, enlarging to *c.* 1.7 mm long in fruit. (Mullewa area) .... **S. bilobum**

      4. Leaves rounded or slightly lobed at apex; upper surface with minute broad protusions. Bracts brown. Floral tube *c.* 1.2 mm long, enlarging to *c.* 2.8 mm long in fruit. (Forrestania area) .... **S. liberum**

    3. Leaves with margins more or less flat or incurved

      5. Leaves minutely stellate-hairy on upper surface. Ovary summit glabrous. Fruit with long deciduous simple hairs, becoming glabrous. (Adelong Station to Kulin to Norseman) .... **S. stipulosum**

      5. Leaves with minute patent simple hairs on upper surface. Ovary summit densely hairy. Fruit hairy, usually densely so, with long simple hairs and short stellate hairs, sometimes becoming almost glabrous. (Dirk Hartog Island to Mullewa).................... **S. complicatum**

  2. Stipules connate for one-third to over half of their length

    6. Floral tube (in flower) with the longest hairs 0.8–1.2 mm long. Sepals with hairs extending c. 0.5 mm beyond the apex

      7. Leaves 5–8 mm long; upper surface with simple patent hairs 0.3–0.4 mm long. (Fitzgerald River National Park).................... **S. cristatum**

      7. Leaves 8–14 mm long; upper surface tuberculate. (E of Walkaway).............**6. S. radiatum**

    6. Floral tube (in flower) with the longest hairs 0.3–0.5 mm long. Sepals with hairs extending 0.1–0.3 mm beyond the apex

      8. Leaves narrowly obtriangular or rarely triangular, the apex emarginate between 2 prominent acute lobes, with minute broad protrusions on upper surface; lower surface with long antrorse simple hairs tending to obscure the stellate ones. (Gunyidi to Stirling Range and Fitzgerald River National Park)............... **S. emarginatum**

8. Leaves narrowly to broadly obovate to obcordate, entire or with 1 or more teeth on each side of apex or with 2 prominent obtuse lobes, either hairy on upper surface or with stellate hairs on lower surface not hidden

  9. Floral tube densely hairy in the lower half and usually throughout. Fruit with a dense covering of short stellate hairs combined with scattered long antrorse hairs, sometimes becoming almost glabrous when very old

    10. Leaves with 1–3 or more teeth on each side of apical point; upper surface glabrous, with minute to short broad protrusions or minute patent to widely antrorse simple hairs

      11. Leaves 2–8 mm long, the margins flat or recurved; upper surface with minute to small simple hairs, sometimes becoming glabrous. Occurring in inland and near-coastal locations, in sandy or clayey soils, sometimes with laterite or granite. (Kalbarri to Mt Ridley)............**S. intricatum**

      11. Leaves 5–15 mm long, the margins recurved; upper surface with minute broad protrusions or rarely with minute simple hairs. Occurring in coastal limestone areas. (Jurien to Perth)......**S. notiale** subsp. **chamelum**

    10. Leaves usually entire, rarely with 1 or 2 teeth on each side of apical point; upper surface usually densely covered by stellate hairs and/or long simple antrorse or appressed hairs, rarely moderately densely hairy (Kalbarri to Stirling Range and Cocklebiddy, also South Australia and Victoria)........................**S. notiale** subsp. **notiale**

  9. Floral tube almost glabrous to moderately densely hairy in lower part. Fruit rather to very sparsely hairy, either with scattered stellate hairs only or with simple hairs, which are often mixed with a few large stellate hairs

    12. Branchlets not spinescent. Leaves with 1 or 2 prominent teeth on each side of apex. Lower floral tube sparsely hairy or glabrous. Fruit largely glabrous but with scattered stellate hairs. (Gunyidi to West River) .... **S. tridentatum**

    12. Branchlets often spinescent. Leaves with 2 obtuse lobes (the apical point recurved). Floral tube moderately densely hairy. Fruit with a rather sparse indumentum of long simple hairs and often also a few stellate hairs. (Quobba Station to Kalbarri) .... **S. divaricatum**

1. Floral tube (in flower) 1.5–6 mm long; free part 0.9–5 mm long, longer than the sepals

  13. Disc apparently absent. Leaves entire

    14. Sepals with a very dense white indumentum of long curled or crisped patent hairs 0.5–1.3 mm long

      15. Leaves narrowly obovate to linear, with revolute margins somewhat separated or meeting below. (Eneabba to Perth).................................. **S. humile**

      15. Leaves narrowly to broadly obovate, obtriangular or obcordate, conduplicate at first, the margins not recurved or, if so, then widely separated below

        16. Leaves 4–14 mm long, opening at centre and sometimes base but remaining closed at apex; upper surface greyish, densely covered with patent simple hairs at first, retaining hairs near midvein and often staying hairy all over. Stipule pairs directly below inflorescence and involucral bracts with two narrow points separated by a sinus

          17. Leaves 7.5–14 mm long. Floral tube (in flower) 2.5–3.5 mm long. (Darling Range near Perth to Highbury) .... **5b. S. pumilum** subsp. **majus**

17. Leaves 4–7 mm long. Floral tube (in flower) 2–2.3 mm long. (Stirling Range) .... **5a. S. pumilum** subsp. **pumilum**

16. Leaves 8–17 mm long, opening fully; upper surface bright green, glabrous or with a few hairs along midvein. Stipule pairs directly below inflorescence and involucral bracts with 2 points tapering from a broad base rather than narrow throughout (York area)...................... **7. S. yorkense**

14. Sepals with appressed or antrorse hairs 0.3–0.5 mm long

18. Leaves 2.5–7 × 2.5–6 mm, with 2 or 3 relatively inconspicuous lateral veins on each side of midvein

19. Leaves minutely stellate-hairy on upper surface (Wilroy to Perenjori and Blue Hill Range area)... **S. poicilum**

19. Leaves smooth or with minute broad protrusions on upper surface. (Marvel Loch to Bremer Range) .... **1. S. bremerense**

18. Leaves 8–23 × 5–12 mm, with 5–8 prominent lateral veins on each side of midvein. (Kalbarri to Yorkrakine)......................... **S. pomaderroides**

13. Disc lining floral tube, with u- or v-shaped sinuses between the stamen traces. Leaves entire to prominently laterally toothed at the apex or emarginate

20. Leaves with upper surface minutely stellate-hairy; petiole 1–5 mm long (Weld Range to North Leonora area)... **4. S. patens**

20. Leaves with upper surface glabrous, with minute broad protrusions or with simple hairs; petiole 0.5–2.5 mm long

21. Stipules free or connate for less than one quarter of their length. Disc with shallow u-shaped sinuses between the stamen traces

22. Leaves with minute simple patent hairs on upper surface. Ovary glabrous. (Die Hardy Range to Koolyanobbing) .... **3. S. newbeyi**

22. Leaves minutely tuberculate on upper surface, sometimes also with a few long appressed hairs. Ovary summit densely hairy. (Mt Augustus to Northern Territory).. **S. petraeum**

21. Stipules connate for one quarter to half their length. Disc with fairly deep v-shaped sinuses between the stamen traces

23. Leaves narrowly obovate, entire, obtuse, without a definite apical point. (Badgingarra area).. **S. reissekii**

23. Leaves obovate or obtriangular to circular, in most taxa laterally toothed at the apex or emarginate, with a recurved to erect apical point, if leaves entire then occurring in arid zone

24. Leaves with apex and margins entire. Occurring in the Eremaean Botanical Province. (Yeelirrie and Black Hill Stations.) .... **S. mediale**

24. Leaves with apex emarginate or with 1 or more small teeth on each side of apex. Occurring in the South West Botanical Province

25. Bracts ovate or broadly ovate. Floral tube 1.5–1.8 mm long in flower, enlarging to 3–3.5 mm in fruit. (Darling Range.)... **S. nanum**

25. Bracts subulate to narrowly triangular. Floral tube 2.5–3.5 mm long in flower, either not distinctly enlarging (*S. coronatum*) or enlarging to 5–6 mm in fruit

26. Outer bracts 2.5–3 mm long. Free part of floral tube densely stellate-hairy (and with simple hairs) not greatly contrasting with the very densely hairy adnate part. Ovary summit glabrous. (Bindoon to Darkan).. **2. S. coronatum**

26. Outer bracts 1.5–2 mm long. Free part of floral tube rather sparsely stellate-hairy (and with a few long simple hairs) in marked contrast to the very densely hairy adnate part. Ovary summit with hairs *c.* 0.2 mm long. (Mt Lesueur area).. **S. limitatum**

1. Stenanthemum bremerense Rye, *sp. nov.*

Stenanthemo poicilo arcte affine sed foliis supra glabratis et plerumque sepalis longioribus magis recurvatis differt.

Typus: Bremer Range, 7 km south of Lake Medcalf, Western Australia, 27 May 2004, *G.F. Craig* 6117 (*holo:* PERTH 06829805; *iso:* CANB).

Shrubs erect or low and spreading, usually (0.2)0.3–0.6 m high, reportedly up to 1.4 m high, single-stemmed at base, sometimes becoming multi-branched at base. *Young stems* with a dense ferruginous indumentum at first of stellate hairs and larger antrorse to patent simple hairs 0.5–0.8 mm long, becoming glabrous. *Stipules* free or connate at base for up to *c.* one-quarter of their length, 2.7–4 mm long, acuminate, with denticulate margins, dark red-brown, becoming black with age; outer surface sometimes denticulate along midrib, with a few short simple hairs or glabrous; inner surface often hairy along midvein. *Petioles* 1–2.5 mm long, densely hairy on undersurface, glabrous on upper surface. *Leaf blades* conduplicate at first, broadly obovate, 3–9 × 2.5–5 mm, entire, with more or less flat margins, with a recurved apical glabrous point 0.3–0.4 mm long; lower surface with 2–4 main lateral veins on each side of midvein, minutely stellate-hairy and with antrorse simple hairs 0.5–0.8 mm long, some of the hairs ferruginous especially along the margin and veins; upper surface smooth or with minute broad protrusions at maturity. *Flower clusters* few- to many-flowered, 5–12 mm diam., white. *Floral tube* 2.5–4 mm long (enlarging to 4–5.5 mm in fruit); adnate part of tube *c.* 0.8 mm long, very densely hairy; free part up to 3 mm long, moderately densely hairy, with appressed simple hairs 0.4–0.7 mm long. *Sepals* 1.5–2 mm long, widely spreading and recurved, with appressed or antrorse simple hairs 0.3–0.5 mm long outside. *Petals* 0.6–0.9 mm long, shortly clawed. *Disc* apparently absent. *Ovary* with summit glabrous. *Style* up to 3.5 mm long. *Fruit c.* 2.5 mm long, hairy. *Seeds c.* 1.7 mm long; body *c.* 1.4 × 1 mm, off-white with a black base and distinctly mottled with brown markings above; aril c. 1 mm long, clear-translucent, 3-lobed.

Selected specimens examined. WESTERN AUSTRALIA: *c.* 0.8 km WSW of Windy Hill Camp access track turnoff, which is 158 km W of Hyden on Hyden–Norseman road, 32°13'S, 120°30'E, 16 June 2002, *P. Armstrong s.n.* (PERTH); Bremer Range, 6.4 km E of Maggie Hays–Ninety Mile Tanks track, on track to Lake Medcalf, 12 Oct. 2003, *G.F. Craig* 5918 (PERTH); Bremer Range, 2 km SSE of Mt Glasse, 7 Nov. 2003, *G.F. Craig* 5976 (PERTH); Windy Hill camp (Emily Ann and Maggie Hays mines), 75 km E of Forrestania Crossroads on Hyden–Norseman road then S of road for *c.* 3 km, 23 June 2005, *G.F. Craig* 6577 (PERTH); Maggie Hays Hill, 32°17'S, 120°35'E, 8 May 1978, *G.J. Keighery* 1687 (PERTH); Marvel Loch Sons of Gwalia Mine, 14 Oct. 2003, *V. Yeomans* A8 (PERTH).

Distribution and habitat. Endemic to the South West Botanical Province of Western Australia, known from many collections in the Bremer Range area and also from a single isolated atypical collection from near Marvel Loch. Occurs on the top or sides of laterite outcrops and breakaways and in other sites with lateritic gravel or pebbles, often in areas with *Allocasuarina* and/or *Melaleuca* species dominant. (Figure 6C)

Flowering period. Mainly recorded April to June, also recorded in October and November.

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. *Stenanthemum bremerense* is common at some localities, with one population having thousands of plants. Its main range seems small but is extended to *c.* 170 km if the atypical specimen is included.

Etymology. Named after Bremer Range as the species occurs mainly in the area near that range.

Affinities. One specimen (*G.J. Keighery* 1687) was previously listed under its very close relative *S. poicilum* Rye when that species was described (Rye 1995). *Stenanthemum bremerense* is geographically separated from *S. poicilum* by at least 350 km and differs in having the upper surface of its leaves smooth or with minute broad protrusions at maturity. It also tends to be a larger plant with longer petioles, leaf blades and sepals. There may be a tendency for the two taxa to flower at different times of the year as the main flowering period recorded for *S. poicilum* so far is from October to December whereas *S. bremerense* has mainly been recorded in flower from April to June.

Notes. This species was previously known as *Stenanthemum* sp. Bremer Range (*G.J. Keighery* 1687). An isolated collection from the Marvel Loch area (*V. Yeomans* A8) seems somewhat atypical in having small leaves and possibly fewer flowers than usual. This variant needs further collection to see whether it differs consistently in any characters and, if so, its status should be reviewed.

2. Stenanthemum coronatum (Reissek) Reissek, *Linnaea* 29: 295 (1858). *Type:* south-western Australia [between Wongan Hills and Augusta, Western Australia], 1842–1843, *J. Drummond* coll. 2: 722 (*iso:* MEL 227036).

Selected specimens examined. WESTERN AUSTRALIA: 11.5 km S of Cachionalgo Hill, off Bindoon–Dewars Pool road, 31°23'S, 116°17'E, 7 Nov. 1996, *M.G. Allen* 246 (PERTH); Bindoon Army Training Area 6 km S of NW corner at W boundary at Sneakers Range, 31°12'S, 116°18'E, 11 Nov. 2002, *F. Hort* 1900 (PERTH); Woondowing Nature Reserve, Jarrah Rd, Wundowie, 5 Nov. 2004, *F. Hort* 2418 *& B. Hort* (PERTH); Julimar Proposed Conservation Park, Beard Rd, Toodyay, 6 Nov. 2005, *F. Hort* 2684 *& J. Hort* (PERTH); Dewars Pool Rd, *c.* 9.4 km E of intersection with Toodyay–Bindi Nindi road, Sep. 2000, *B. Morgan* 9 (PERTH).

Notes. The known range of this species has been extended north to the Bindoon Army Training Area. Populations in the Bindoon area (two cited above being *M.G. Allen* 246 and *F. Hort* 1900), tend to have coarser and/or longer hairs on the upper surface of the leaves than specimens occurring from Toodyay south to the Bowelling area (between Collie and Darkin), but this slight difference in indumentum is not sufficiently well defined to suggest that the northern variant should be recognised formally.

Mature fruits are more or less globular, the floral tube circumscissile at the top of the fruit, 2–2.3 mm long, sparsely covered by minute stellate hairs and much longer simple hairs. Seeds are 1.5–1.7 mm long, with a seed body 1.4–1.5 × 0.8–1 mm and a prominently 3-lobed clear-translucent aril 0.7–0.9 mm long. The testa has a black base and is distinctly mottled above with red-brown patches over a straw-coloured background.

3. Stenanthemum newbeyi Rye, *Nuytsia* 10: 293–295 (1995). *Type:* Bungalbin Hill, Western Australia, 2 January 1989, *D.J. Pearson* 559 (*holo:* PERTH 01679538).

Selected specimens examined. WESTERN AUSTRALIA: Helena and Aurora Range, *c.* 50 km NNE of Koolyanobbing, 8 Oct. 2004, *V. Clarke* 501 (PERTH); *c.* 12.5 km NE of Barcooting Hill, Ennuin Station, 18 Oct. 1996, *N. Gibson & M.N. Lyons* 2735 (PERTH).

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. Many new collections of this species have extended its known range north to Die Hardy Range, south to Koolyanobbing and west to Ennuin Station. Although many more populations are now known over a distance of *c.* 70 km, many of them are in areas where mining is proposed.

Notes. New fruiting collections, including two cited above, are the first to contain mature seeds. The fruits (excluding attached floral parts) are 2.6–3 mm long, with seeds 2–2.4 mm long. Seeds have a darkly mottled (with dark patches covering much more of the surface than the pale patches) or sometimes completely dark body 1.4–1.7 × 0.8–1.2 mm and a prominently 3-lobed whitish to cream- or clear-translucent aril 0.8–1.2 mm long, with the lateral lobes as long as or longer than the central lobe.

4. Stenanthemum patens Rye, *Nuytsia* 13: 503–505 (2001). *Type:* between Teutonic and Mt Clifford [precise locality withheld], Western Australia, 16 August 1981, *R. Cumming* 1267 (*holo:* PERTH 02937786; *iso:* CANB).

Selected specimens examined. WESTERN AUSTRALIA: Weld Range, NW of Cue, 31 Aug. 2005, *Markey & Dillon* 3094, 3095 (PERTH).

Conservation status. Conservation Codes for Western Australian Flora: Priority One. A new collection of this species from Weld Range has extended its known range westwards by almost 400 km. However, this small new population is in an area marked for roadworks and drill sampling and is expected to be destroyed when this mining survey work is completed. Further populations of the species would probably be discovered if rocky habitats in the intermediate area between the two known locations could be thoroughly surveyed.

Notes. The new material of this species is the first to contain mature seeds. The seeds are *c.* 2.8 mm long with a darkly mottled body *c.* 2.4 × 1.6 mm and a prominently 3-lobed white-translucent aril *c.* 1.7 mm long. One of the plants sampled from this new population had large leaves with a petiole 4–5 mm long and a blade up to 13 mm long.

5. Stenanthemum pumilum (F.Muell.) Diels *in* Diels & E. Pritzel, *Bot. Jahrb. Syst.* 35: 356 (1904). – *Spyridium pumilum* F. Muell., Fragm. Phyt. Austral. 9: 137 (1975). – *Cryptandra pumila* (F. Muell.) F. Muell., Syst. Census Aust. Pl. 61 (1882–1883). *Type:* Stirling Range, Western Australia, *F. Mueller* (*holo:* MEL *n.v.*).

Affinities. See notes under its closest relative *Stenanthemum yorkense* Rye.

Notes. Stenanthemum pumilum has two geographically separated variants described separately below. Differences between them are all quantitative rather than qualitative and so these two taxa are treated here as subspecies rather than distinct species.

5a. **Stenanthemum pumilum** (F.Muell.) Diels subsp. **pumilum**

Illustration: Rye (1995b: fig. 12 G,H).

Shrubs low and spreading, probably up to 0.1 m high but mostly 20–50 mm high, up to at least 0.15 m wide. *Young stems* with a very dense indumentum of appressed simple white hairs mostly 0.5–0.7 mm long. *Stipules* connate at base for *c.* half or most of their length, 2.5–3.5 mm long, papery and readily town, brown, long-ciliate at first, apex acuminate below a point 0.8–2 mm long; outer surface with long appressed simple hairs all or mainly along midrib; inner surface glabrous; point hairy, separated from the point of the other stipule by a sinus, which often has several small teeth or a longer central tooth. *Petioles* 1–1.5 mm long, densely hairy on both surfaces at first. *Leaf blades* conduplicate at first then opening at centre and sometimes at base but with the apex remaining pinched in, obovate, 4–7 × 1.4–2.5 mm, entire, with more or less flat margins, unpointed or sometimes with a narrow hairy apical point or an apical tuft of hairs up to 0.4 mm long; lower surface without any conspicuous lateral veins and with a very dense indumentum of appressed simple white hairs mostly 0.7–1.3 mm long at first, sometimes with a few ferruginous hairs, becoming less densely hairy and with 4–8 main lateral veins visible on each side of midvein; upper surface greyish, covered in minute simple patent hairs at first, becoming dark grey-green and almost glabrous but retaining at least some hairs along the midvein. *Flower clusters* few- or many-flowered, 6–10 mm diam. *Floral tube* 2–2.3 mm long, tapering towards the base; adnate part of tube glabrous at base, with antrorse simple hairs towards summit; free part *c.* 1.5 mm long, very densely hairy, with spreading simple white hairs that are not as curled as the hairs on the sepals, the longest ones *c.* 1.5 mm long. *Sepals* spreading at anthesis but fairly erect at other times, 1–1.2 mm long, very densely covered outside by irregularly curled widely spreading white hairs 0.5–0.8 mm long. *Petals* 0.5–0.6 mm long, the claw up to *c.* 0.25 mm long. *Disc* apparently absent. *Ovary* with summit glabrous. *Style* 1.6–2.2 mm long. *Fruit* 2–2.3 mm long, hairy at first, becoming glabrous. *Seeds* 1.5–1.6 mm long; body *c.* 1.4–1.5 × 0.8–0.9 mm, with a dark brown base and somewhat mottled pale and medium brown above; aril *c.* 0.7 mm long, pale ferruginous- or clear-translucent, 3-lobed, the central lobe much longer than the lateral lobes.

Selected specimens examined. WESTERN AUSTRALIA: Stirling Range *c.* 2 km from car park, 26 Sep. 1996, *B.A. Fuhrer* 96/26 (PERTH); Warrungup Hill, Stirling Range, 12 Oct. 1928, *C.A. Gardner* 2200 (PERTH); Stirling Range Scenic Drive, NE of Mondurup, 6 Sep. 1971, *A.S. George* 10918 (PERTH); 1.39 km N of West Pillenorup Track on Hostellers Track, 26 Jan. 1989, *R.T. Wills* 1253 (PERTH); Chester Pass, East Stirlings, 26 Sep. 1963, *E. Wittwer* 212 (PERTH).

Distribution and habitat. Endemic to the Stirling Range, in the South West Botanical Province of Western Australia, with two records from gravel, one record in rocky sandy soil in *Eucalyptus* high shrubland and one record from massive laterite. (Figure 6C)

Flowering period. Flowers early September to mid October. Seeds measured from *C.A. Gardner* 2200.

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. This subspecies is endemic to the Stirling Range. Most collections were made before 1975 but the most recent collection was in 1996, and another collection was made in 1989 as part of a study (Wills 1993) into the ecological impact of *Phytophthora cinnamomi* in the Stirling Range. That paper made no mention of the Rhamnaceae but most Rhamnaceae appear from field observations not to be susceptible to the dieback fungal disease so presumably *S. pumilum* is not at risk.

5b. **Stenanthemum pumilum** subsp. **majus** Rye, *subsp. nov.*

Differt a subsp. *pumilum* foliis et floribus grandioribus.

Typus: c. 100 m SW of Metro Rd, 2.1 km S from Brookton Highway, Wandering Shire, Western Australia, 29 January 1999, *F. Hort* 407 (*holo:* PERTH 05377331; *iso:* CANB).

Illustration: Rye (1995b: fig. 12 I–K).

Shrubs low and spreading, probably up to 0.15 m high, mostly 30–120 mm high, width not or rarely recorded. *Young stems* with a very dense indumentum of appressed simple white hairs mostly 0.5–1 mm long. *Stipules* connate at base for *c.* half or most of their length, commonly 3–4 mm long, papery and readily town, apex acuminate below a point 1–1.5 mm long, brown, long-ciliate at first; outer surface with long appressed simple hairs all or mainly along midrib; inner surface glabrous; point hairy, separated from the point of the other stipule by a sinus, which often has several small teeth or a longer central tooth. *Petioles* 1.5–3 mm long, densely hairy on lower surface at first, glabrous to densely hairy on upper surface. *Leaf blades* conduplicate at first then opening at centre but with the base and apex remaining pinched in, obovate, (7.5)9–14 × 3–5 mm, entire, with incurved margins, unpointed or sometimes with an apical tuft of hairs or narrow hairy apical point up to 0.5 mm long; lower surface without any conspicuous lateral veins and with a very dense indumentum of appressed simple white hairs mostly 0.6–1 mm long at first, sometimes with a few ferruginous hairs, becoming less densely hairy and with 7–12 main lateral veins visible on each side of midvein; upper surface covered in minute simple patent hairs at first, becoming almost glabrous but retaining at least some hairs along the midvein, sometimes with a few larger simple hairs c. 0.3 mm long towards the base. *Flower clusters* usually many-flowered, mostly 8–10 mm diam. *Floral tube* 2.5–3.5 mm long, tapering towards the base; adnate parte often more or less glabrous at base; free part 1.8–2.6 mm long, very densely hairy with antrorse to spreading hairs that are somewhat or much less curled than those on sepals, the longest hairs up to *c.* 2 mm long. *Sepals* spreading at anthesis but fairly erect at other times, 1.1–1.3 mm long, with a very dense indumentum outside of irregularly curled widely spreading white hairs 0.6–1 mm long. *Petals* 0.6–0.7 mm long, narrowly clawed; claw 0.25–0.3 mm long. *Disc* apparently absent. *Ovary* with summit glabrous. *Style* 2.4–3 mm long. *Fruit* broadly obovoid to globular, 2.3–2.6 mm long, pale to medium brown for most of its length, darker brown towards the summit, with fine simple long hairs loosely attached, often becoming glabrous. *Seeds* 1.6–1.9 mm long; body 1.4–1.6 × 0.9–1.1 mm, with a dark or very dark brown base and mottled or spotted with pale and medium shades of brown above; aril 0.8–1.3 mm long, partly yellowish or pale ferruginous and partly clear-translucent, 3-lobed, the central lobe often far longer than the lateral lobes.

Selected specimens examined. WESTERN AUSTRALIA: 10 km S along Watershed Rd off Brookton Highway, 19 Nov. 1981, *R.J. Cranfield* 1971 (PERTH); 100 m W of Metro Rd, 19.5 km S from Brookton Highway, Wandering Shire, 21 Sep. 2001, *J. Kellermann* 315 *& F. Hort* (PERTH); Lupton Conservation Park, 1.1 km WNW along Perimeter Rd from the junction of East Rd, 7 Oct. 1997, *J.L. Robson s.n.* (PERTH); Moorapulling Nature Reserve No. 32448, 27 Nov. 1997, *J.L. Robson s.n.* (PERTH); Coleman Block, State Forest 52, E of Yarranabee Road, SW of Highbury, 19 Oct. 1999, *G. Warren, C. Taylor & P. Rose* 414 (PERTH).

Distribution and habitat. Endemic to the South West Botanical Province of Western Australia, extending from near Brookton Highway on the Darling Range (east of Perth) south-east to near Highbury, usually in gravelly soils, often associated with laterite or granite sheets and outcrops, commonly with *Allocasuarina humilis* and a variety of eucalypt species. (Figure 6C)

Flowering period. Flowers mainly from mid September to early December. Mature fruits and seeds observed on *R.J. Cranfield* 1971, *J.L. Robson s.n.* 4 Dec. 1997 and *J.L. Robson s.n.* 15 Oct. 1997.

Conservation status. This taxon is known from more than 15 populations over a range *c.* 125 km long and does not appear to be under any immediate threat.

Etymology. Named from the Latin word *majus* (greater), referring to the larger size of the leaves, flowers and often also the larger habit of this subspecies.

Notes. The distance separating the known ranges of this subspecies and *Stenanthemum pumilum* subsp. *pumilum* is over 150 km. The new taxon differs in being larger in many of its vegetative and floral characters, including its floral tube and style, and possibly tends to have a larger seed. It also tends to be a larger plant.

6. **Stenanthemum radiatum** Rye, *sp. nov.*

Stenanthemo cristato simile sed foliis supra glabratis, foliis longioribus et inflorescentiis grandioribus differt.

Typus: Burma Road Nature Reserve [precise locality withheld], Western Australia, 23 Oct. 1998, *G.J. Keighery & N. Gibson* 2904 (*holo:* PERTH 05784158).

Shrubs spreading, 0.1–0.3 m high. *Young stems* often leafless except for the leaves surrounding each inflorescence, with a rather sparse indumentum at first of small white stellate hairs but no simple hairs, becoming glabrous. *Stipules* connate at the base, those surrounding the inflorescence connate for most of their length, 2–3 mm long, broad, densely hairy along midvein outside and sparsely hairy laterally, golden-brown. *Petioles* 1–2 mm long, densely hairy on undersurface, glabrous on upper surface. *Leaf blades* narrowly triangular to cordate, 8–14 × 3–5 mm, mostly with 2 large lobes (the apex emarginate), often also with a central apical tooth between the lobes, sometimes with 2–4 teeth across a more truncate summit, margins strongly recurved; lower surface with a white or partially ferruginous dense indumentum of stellate hairs and larger simple antrorse or appressed hairs, the simple hairs up to *c.* 1 mm long; upper surface with minute broad protrusions, green. *Flowers* densely crowded in a terminal head-like cluster 5–8 mm diam., white, surrounded by several or a circle of spreading leaves that give the whole inflorescence a somewhat daisy-like appearance. *Floral tube c.* 1 mm long (enlarging to *c.* 2 mm in fruit), very densely hairy, the free part longer than adnate part but shorter than the sepals; largest hairs simple, antrorse, 0.8–1.2 mm long. *Sepals c.* 1 mm long, very densely hairy, the long simple hairs extending *c.* 0.5 mm beyond the apex. *Petals c.* 0.6 mm long; claw 0.2–0.3 mm long. *Disc* lining floral tube, scooped between the stamens. *Ovary* 3-locular; summit with a few stellate hairs *c.* 0.3 mm long. *Style* 0.6–0.8 mm long. *Fruit* 1.8–2 mm long, densely hairy. *Seeds c.* 1.3 mm long; body *c.* 1 × 0.6–0.8 mm, off-white with a black base and a few small dark brown markings on lateral surfaces; aril 0.6–0.8 mm long, clear-translucent, with most of its length derived from its very large central (adaxial) tooth-shaped lobe, the lateral lobes also tooth-like but short.

Other specimens examined. WESTERN AUSTRALIA: Burma Road Nature Reserve, [precise locality withheld], 7 Nov. 2005, *A. Franks, S. Branigan & B. Smith* 213 (AD, PERTH); Burma Road Nature Reserve, [precise locality withheld], 22 Sep. 1997, *S.J. Patrick* 2981 (PERTH).

Distribution and habitat. Endemic to the South West Botanical Province of Western Australia. Known only from Burma Road Nature Reserve, which is between Geraldton and Mingenew in the area east of Walkaway. Recorded in grey sand over laterite in vegetation with *Calothamnus*, *Hakea* and *Allocasuarina*. (Figure 6C)

Flowering period. September to November.

Conservation status. Conservation Codes for Western Australian Flora: Priority Two. Currently known from a single population in a nature reserve, where it is recorded as being common.

Etymology. The name comes from the Latin *radiatus* (with spokes, radiating), as this species has leaves closely subtending the inflorescence and radiating out from the central dense cluster of flowers.

Affinities. The closest relative of this species appears to be *Stenanthemum cristatum* Rye, a species occurring on the south coast *c.* 700 km away from the only known locality of *S. radiatum*. Both species are rare, perhaps being the last remnants of a group that was once widespread in the south-west. The new species has larger leaves and inflorescences than *S. cristatum* and the flower heads have a more fluffy appearance. It also has the upper leaf surface glabrous whereas *S. cristatum* has more or less patent simple hairs on the upper leaf surface. From the little available fruiting material of the two taxa it appears that *S. cristatum* has larger fruits and seeds with a more extensively mottled testa, but these differences need confirmation.

Another possible close relative is *Stenanthemum intricatum* Rye, which has similar seed colouring and a similar long aril but lacks the prominent tuft of hairs on its sepals.

Notes. This species was previously known as *Stenanthemum* sp. Burma Road (*G.J. Keighery & N. Gibson* 2904). In the first two collections of *Stenanthemum radiatum*, the stems are bare except for the groups of leaves closely surrounding each inflorescence or infructescence but a recently collected specimen also has scattered leaves up the stems. Stipules on the leaves directly surrounding the inflorescences are more or less fully connate and resemble a single structure with 2 slight rounded lobes at the apex. One of the leaves appears to be conduplicate because of the way it was pressed but the others are all fairly open. Probably the immature leaves would be conduplicate, but more material needs to be collected to check this.

7. **Stenanthemum yorkense** Rye *sp. nov.*

Stenanthemo pumilo arcte affine sed pilis in caule brevioribus, foliis longioribus planioribus, stipularum paribus et bracteis involucri cum apicus acuminatus latioribus, et floribus longioribus differt.

Typus: York area [precise locality withheld], Western Australia, 4 July 2005, *A. Sole & H. Green* KB22 (*holo:* PERTH 07350457; *iso:* MEL).

Shrubs low and spreading, commonly 0.1–0.15 m high and 0.2–0.25 m wide. *Young stems* with a dense indumentum of appressed or antrorse simple whitish hairs mostly 0.2–0.3 mm long. *Stipules* connate at base for *c.* half or most of their length, 5–6 mm long, long-acuminate, brown; outer surface with a few appressed simple hairs especially along midrib; inner surface glabrous; acuminate points broad, meeting at the base. *Petioles* 3–4 mm long, densely hairy. *Leaf blades* conduplicate at first but opening fully, obovate to very broadly obovate, 8–17 × 4–8 mm, entire, with more or less flat margins, mostly with a slight apical point 0.2–0.3 mm long; lower surface with 5–8 main lateral veins on each side of midvein, with appressed simple white hairs mostly *c.* 0.5 mm long, sometimes with some ferruginous hairs along the main veins; upper surface bright green, smooth or minutely patterned, glabrous throughout or sometimes with a few short simple hairs along the midvein. *Flower clusters* few- or many-flowered, the larger ones 10–14 mm diam. *Flowers* white with a yellow centre. *Floral tube* 3.5–4.5 mm long, tapering towards the base; adnate part of tube tending to shed its hairs; free part *c.* 3 mm long, very densely hairy, with spreading simple curled hairs, the longest ones *c.* 1 mm long. *Sepals* fairly erect or spreading, *c.* 1.3 mm long, very densely covered outside by curled white hairs 0.6–0.7 mm long. *Petals c.* 0.6 mm long, distinctly clawed. *Disc* apparently absent. *Ovary* with summit glabrous. *Style c.* 3.8 mm long. *Fruit* globular, *c.* 2.x mm long, with loose long hairs, tending to become glabrous. *Seeds c.* 1.6 mm long; body *c.* 1.5 × 1 mm, with a black base and distinctly mottled with three shades of brown above; aril *c.* 0.7 mm long, white-translucent, 3-lobed, the central lobe much longer than the lateral lobes.

Other specimen examined. WESTERN AUSTRALIA: York area [precise locality withheld], , 13 Nov. 2004, *A. Sole & H. Green* KB64 (PERTH).

Distribution and habitat. Endemic to the South West Botanical Province of Western Australia, known from a single collection in the York area, from a quartzite hilltop, with *Eucalyptus accedens* and *Allocasuarina.* (Figure 6C)

Flowering period. Unknown. This species was collected with mature fruits in early July.

Conservation status. Conservation Codes for Western Australian Flora: Priority One. This very poorly known species appears to be restricted to a single hill or small range of hills on private land and is currently known from one large population.

Etymology. Named after the town of York, which is the closest large settlement to the only known population of this species.

Affinities. The closest relative of this species is *Stenanthemum pumilum*, a species with similar inflorescences, sepal indumentum and seeds. There are also many differences between the two species, as *S. yorkense* has a more open habit, stipules with broader closer acuminate points (*cf.* Rye 1995: fig. 12H of the stipules of subsp. *pumilum* with their more filiform and widely spaced points), larger leaves with the bright green upper surface opening fully, and longer flowers with a longer style. All vegetative parts tend to be less hairy, for example the hairs on the young stems are shorter and more discrete in the new species. *Stenanthemum yorkense* is also geographically separated from *S. pumilum*, occurring more than 50 km north-eastwards from the range of *S. pumilum* subsp. *majus*.

Notes. The type collection has mature fruiting inflorescences with most of the seeds already shed. Only one mature seed was measured. In fruit the sepal hairs are reduced in length to 0.3–0.4 mm.

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Tecticornia bibenda (Chenopodiaceae: Salicornioideae), a new C_4 samphire from the Little Sandy Desert, Western Australia

Kelly A. Shepherd[1,2] **and Stephen J. van Leeuwen**[3]

[1] Western Australian Herbarium, Department of Environment and Conservation,
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983
[2]School of Plant Biology, The University of Western Australia, 35 Stirling Highway, Crawley, Western Australia 6009
[3] Wildlife Research Centre, Department of Environment and Conservation,
PO Box 51, Wanneroo, Western Australia 6946

Abstract

Shepherd, K.A. & van Leeuwen, S.J. *Tecticornia bibenda* (Chenopodiaceae: Salicornioideae), a new C_4 samphire from the Little Sandy Desert, Western Australia. *Nuytsia* 16(2): 383–391 (2007). *Tecticornia bibenda* K.A. Sheph. & S.J. van Leeuwen, a new species of conservation significance is described and illustrated. Previously *Tecticornia indica* (Willd.) K.A. Sheph. & Paul G. Wilson (formerly *Halosarcia indica* (Willd.) Paul G. Wilson) was the only member of the Salicornioideae that was known to have a modified Kranz anatomy indicative of the C_4 photosynthetic pathway. Anatomical evidence indicates that *T. bibenda* shares a similar modified anatomy. While *T. bibenda* is related to *T. indica*, it is distinguished by the presence of unusually large vegetative and fertile articles and having paired cymes of (4)5–7 flowers rather than the more typical 3-flowered cymes. This species is restricted to the flood zones and fringing spinifex/samphire heath of several gypsiferous playa and salt lake systems in the Little Sandy Desert of Western Australia. Due to its restricted distribution this species has a Priority three conservation status.

Introduction

The newly expanded *Tecticornia* Hook.f., which includes all of the Australian genera of the Salicornioideae Kostel. (Chenopodiaceae Venet.) except *Sarcocornia* Scott, is the largest genus of this subfamily (Shepherd & Wilson 2007). Commonly known as samphires, these unique plants are among the most salt tolerant land plants (Short & Colmer 1999; English 2004) and predominate in the vegetation around the margins of Australian inland salt lakes.

The Little Sandy Desert is one of the most recently recognised natural regions but also the least understood and appreciated areas in Western Australia with respect to its biota and natural history. The Desert was not formally recognised until 1969 (Keartland Botanical District, Beard 1970) and until recently received little attention with respect to its biodiversity values. The first biological work undertaken in the Desert was by Earnest Giles in 1876 (Giles 1889). During this expedition Giles collected several plant specimens, the most noteworthy (and subsequently legendary) of these being *Eucalyptus rameliana* F. Muell., which until its rediscovery in the Little Sandy Desert in July 1991 was presumed to be the only extinct *Eucalyptus* (Hopper 1992). This rediscovery, together with initiatives designed to conserve biodiversity through the establishment of a comprehensive, adequate and representative reserve network fostered a sustained period of interest in this bioregion that culminated in a biological survey of the south-western Little Sandy Desert (National Reserve System Project N706) in the late 1990s (van Leeuwen 2002).

In 1996, while undertaking field sampling for this biological survey, a morphologically distinct samphire was encountered on the fringes of Yanneri Lake. Over the subsequent six years several additional populations were located within a radius of 35 km. All populations fringe gypsiferous playa or salt lakes with well developed fringing samphire and samphire/spinifex heaths. As this species is geographically and edaphically restricted, it was considered to be a priority for naming and *Tecticornia bibenda* K.A. Sheph. & S.J. van Leeuwen is here described.

Methods

This study is based on the examination of herbarium specimens lodged at PERTH and from fresh or spirit material preserved in 70% ethanol collected in the field. Images of the seed were produced using an Environmental Scanning Electron Microscope (Danilastos 1993).

A detailed description of the morphological variation in the Australian Salicornioideae is outlined in Shepherd (2004), Shepherd *et. al.* 2005b (see Table 5) and Shepherd and Wilson (2007) (see Appendix 1). Due to the highly reduced morphology typical of samphires the terminology used to describe the inflorescence structure is further clarified here. Inflorescences are comprised of opposite pairs of bracts in a decussate arrangement. Each bract pair may be free or fused. The shape of each bract and the degree of curvature of the upper edge is firstly described from the face or front-on view, where the bract is at its widest. The side view is then described where the bract is at its narrowest and may fuse with the opposite bract. The degree of protrusion of the outer face in the front-on view may range from flat to strongly protruding. The apex of the bract may be truncate to acuminate and the margin entire or dissected. Subtending bracts may also overlap the bract pair above.

Anatomical sections were made from fresh material fixed in 2.5–5% glutaraldehyde in 0.05 M phosphate buffer (pH 7.0) and then embedded in Glycol Methacrylate (GMA) resin following the methods of O'Brien and McCully (1981). The fixed material was washed in buffer and dehydrated through a series of alcohol solutions (methoxyethanol, ethanol, 1-n-propanol and 1-n-butanol) for a period of 24 hours each. The material was transferred through two changes of GMA and then polymerised at 60° for 8 hours under oxygen free conditions. A Sorvall semi-automatic microtome with a glass knife was used to make ultra-thin sections (2–4 μm) in the transverse (TS) plane. Sections were mounted and fixed on a glass slide using a hotplate and subsequently stained using Toluidine Blue (pH 4.4). Images were taken using the Zeiss Axiocam system on a Zeiss Optical Microscope.

The species distribution map was created using MapInfo software. The distribution map inset is based on Version 5.1 of the Interim Biogeographic Regionalisation for Australia categories (Thackway & Cresswell 1995; Environment Australia 2000). Due to conservation concerns the precise localities for Priority species are withheld.

Results and Discussion

The Salicornioideae are distinguished by their articulated photosynthetic stems. These stems consist of vegetative articles that typically have a uniseriate epidermis and a simple cuticle layer. In the majority of samphires the epidermis is subtended by a thin layer (1–3 cells thick) of photosynthetic palisade. These palisade cells may merge either abruptly or gradually into an 'aqueous' tissue layer of thin-walled, fluid filled parenchyma that surrounds the central stele (Wilson 1980; Carolin *et al.* 1982; Shepherd 2004). The shape of epidermal cells is variable among samphires (Shepherd 2004) and the epidermal cells of *T. bibenda* are irregular (Figure 1) rather than even, giving the outer epidermis a dull appearance. The stomata of *T. bibenda* are orientated perpendicular to the main stem axis and are slightly sunken below the outer surface of the epidermis. The vascular bundles are present in the central stele. Within each vegetative article two large strands branch from the central stele and traverse each side of the node, branching and forming a network throughout the article. In *T. bibenda* the photosynthetic palisade is comprised of two distinct forms of cells: an upper layer of palisade cells clustered below each stomate interspersed with larger cylindrical clear cells; and a subtending layer of tightly packed isodiametric chlorenchyma cells (Figure 1). This unusual palisade anatomy was first discovered by Wilson (1980) who noted that *Halosarcia indica* (now *Tecticornia indica*) was the only representative of the Salicornioideae with a modified Kranz anatomy which is typical of plants that utilise the C_4 rather than C_3 photosynthetic pathway. Carolin *et al.* (1982) later confirmed that *T. indica* was indeed a C_4 species using labelled $\delta^{13}C$.

Tecticornia bibenda is allied to *T. indica* through similar floral and fruit characters and the modified Kranz stem anatomy however, the distinct habit (Figure 2), unusually large vegetative and fertile articles (Figure 3) and paired cymes of (4)5–7 flowers (Figure 4E) clearly set it apart. Moreover, molecular sequence evidence shows that *T. bibenda* is related to *T. indica* but is supported as distinct (Shepherd *et al.* 2004; Shepherd *et al.* 2005b).

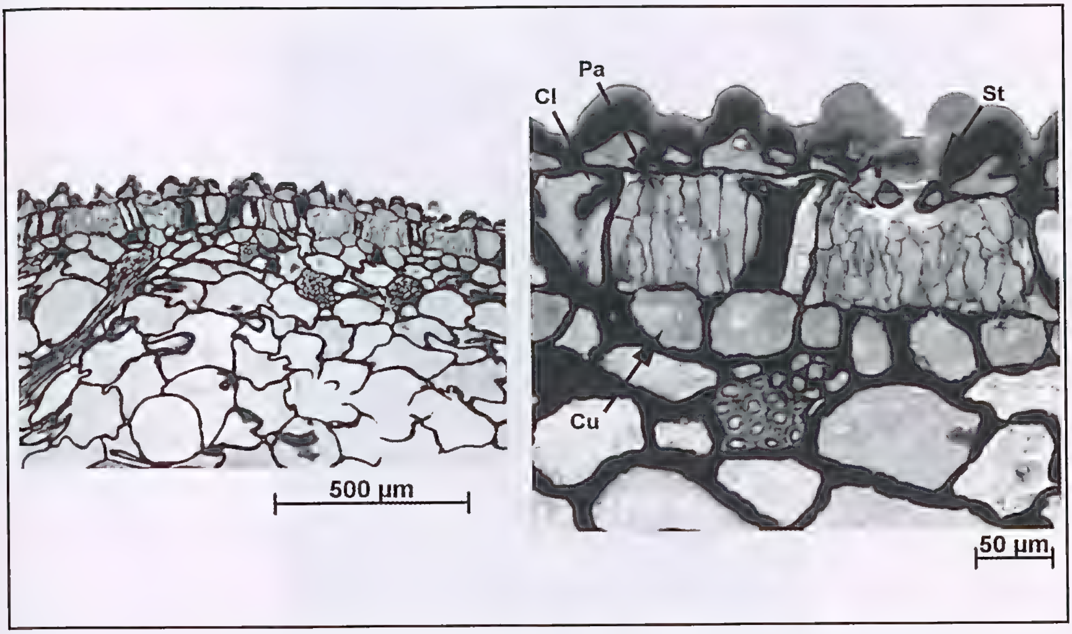

Figure 1. Transverse anatomical sections of a vegetative article of *Tecticornia bibenda* highlighting the irregular epidermal cells and the modified Kranz anatomy; pa – palisade, cu – cuboid cells, cl – clear cells and st – stomata (*K.A. Shepherd & C.F. Wilkins* KS 836).

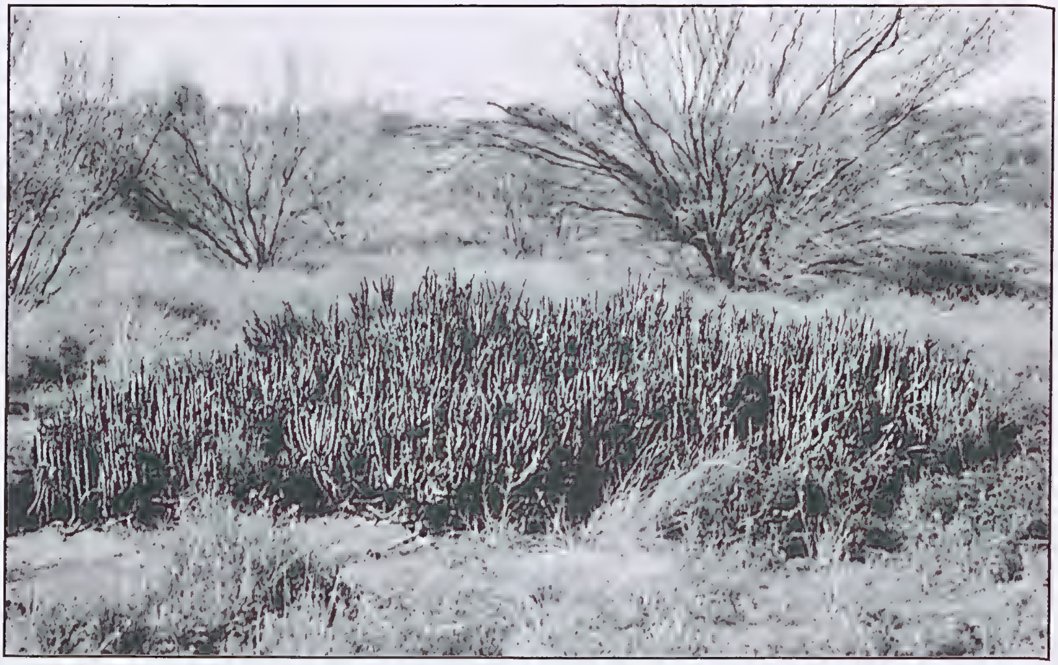

Figure 2. Large spreading shrubs of *Tecticornia bibenda* growing in the typical swale habitat in the floodzone of salt lakes in the Little Sandy Desert, Western Australia.

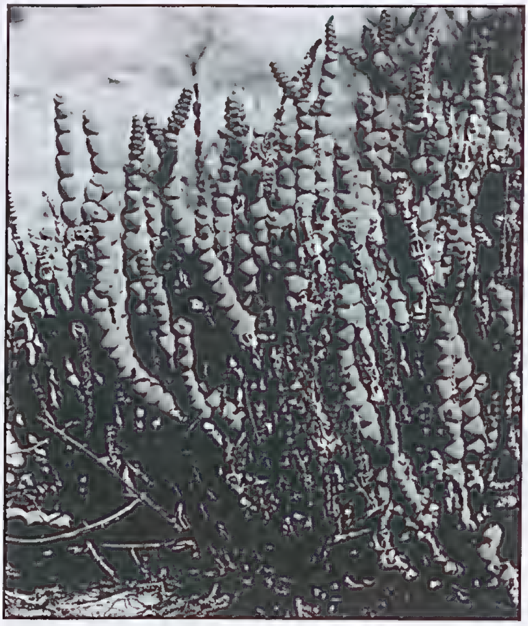

Figure 3. *Tecticornia bibenda* is distinguished by the presence of very large articles which are up to 12.5–24 mm long and the (4)5–7 flowers in each paired cyme of the inflorescence.

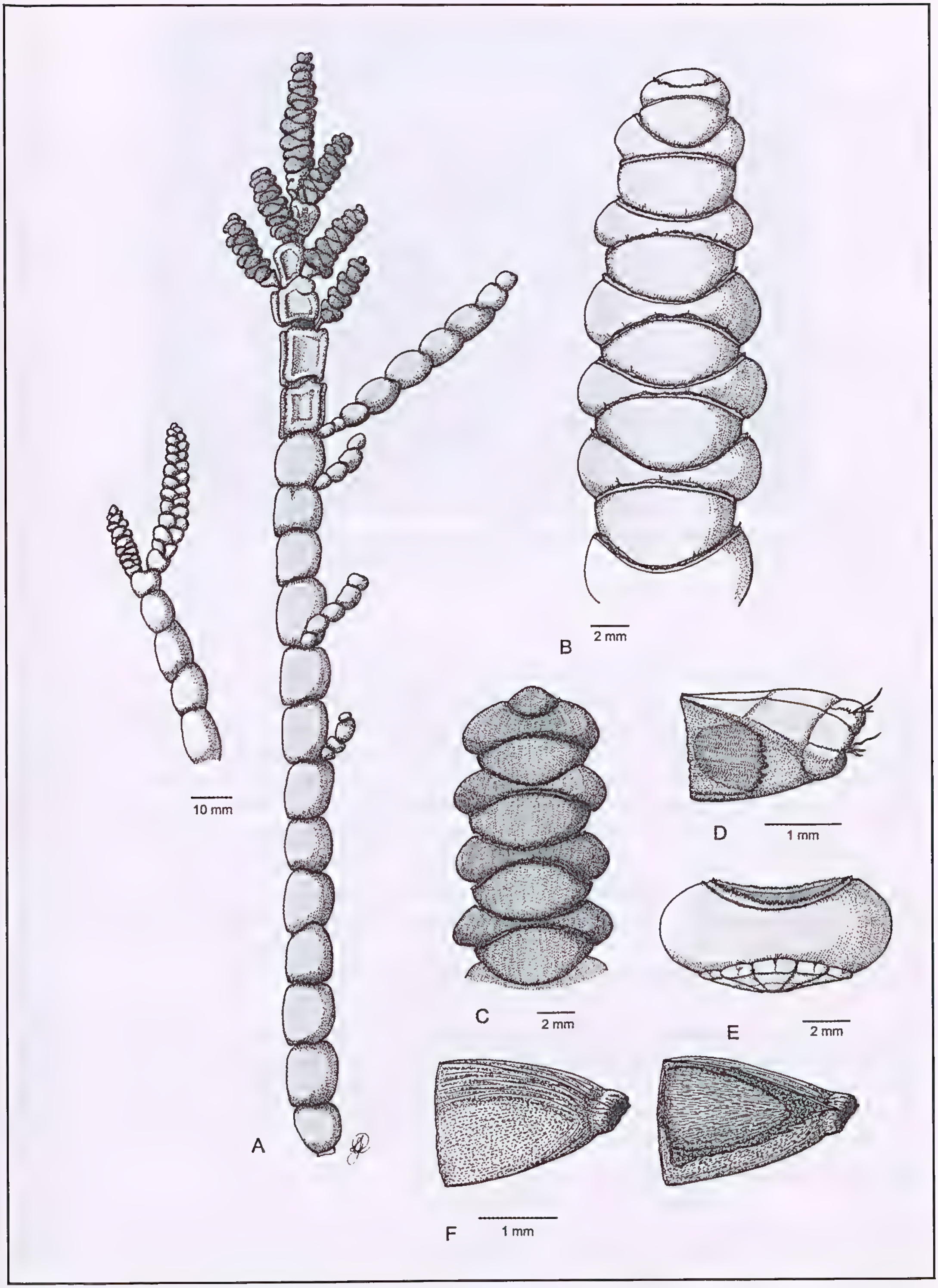

Figure 4. *Tecticornia bibenda* (*K.A. Shepherd & C.F. Wilkins* KS 836). A – flowering branches; B – inflorescence; C – persistent fruiting spike; D – lateral view of two adjacent florets with the ovary exposed at the torn base; E – fertile article with the five florets exposed at the base; F – lateral view of a fruitlet and L.S. showing the firm woody pericarp enclosing the seed.

Taxonomy

Tecticornia bibenda K.A. Sheph. & S.J. van Leeuwen *sp. nov.*

A *Halosarciae indicae* articulis marginibus grandioribus, 'Kranz' anatomia mutata, et cymis paribus (4)5–7 floribus continentibus statim dignoscenda.

Typus: Yanneri Lake, Little Sandy Desert, Western Australia [precise locality withheld], 17 August 2001, *K.A. Shepherd & C.F. Wilkins* KS 836 (*holo*: PERTH 07462786; *iso*: CANB).

Halosarcia sp. Yanneri Lake (S. van Leeuwen 3002), G. Paczkowska & A.R. Chapman, WA Fl. Descr. Cat.: p. 205 (2000).

Illustration: Nikulinsky, P. & Hopper, S.D. (2005). *Soul of the Desert.* p. 125 pl. 44 (as *Haloscarcia* sp.).

Perennial, erect or spreading shrub, 0.5–1.2 m tall and 2–4 m wide. *Vegetative articles* cylindrical or barrel-shaped, circular in cross section, dull green or deep red to burgundy, 12.5–24 mm long, 11–22 mm wide, apex rounded or truncate, margin ciliate; palisade modified Kranz anatomy. *Inflorescence* 18–45.5 mm long, 8–10 mm wide, of (4)5–7-flowered cymes forming a spike of 9–25 nodes, with a very strongly undulating, cylindrical outline; terminal to main or lateral branches. *Bracts* fused, convex in face view with the upper edge gently curved, concave in side view with the upper edge curved to strongly curved, outer face of bract protruding, apex truncate, margin entire or ciliolate to denticulate; with strongly overlapping subtending bracts. *Flowers* hermaphrodite, fully covered or partially exposed by subtending bracts, fused to bracts above and with adjacent flowers, free from opposite flowers. *Perianth* fused and laterally square, with the adaxial and abaxial surfaces horizontal, apex truncate; lobes 3 with 2 lateral and a small inner, central abaxial lobe, margins entire. *Stamen* 1, the anther elliptic and abaxial to the ovary. *Ovary* free from the stem cortex; style bifid, membranous. *Fruiting spikes* scarcely expanded, pithy and firm, persisting on dead branches, apical vegetative growth absent; seed released only after the eventual decay of the bracts and perianth. *Fruitlets* partially obscured by the subtending bract, fused to bracts above, fused to adjacent fruitlets and free from opposite fruitlets; fruiting perianth soft and spongy or pithy and firm, enclosing the seed, dehiscing ± in the medial plane. *Pericarp* hard and horn-like, fused with the perianth, free from the seed. *Seed* horizontal relative to the stem axis, ovate or orbicular, slightly beaked, 1.0–1.5 mm long, opaque, gold-brown without ornamentation. *Embryo* straight, perisperm present. (Figures 1–5)

Specimens examined. WESTERN AUSTRALIA: 17 Oct. 1997, *K. Kershaw s.n.* (PERTH 05287154); 24 Aug. 1997, *L. Sweedman* 4546 (PERTH 04920678); 23 Oct. 1996, *S. van Leeuwen* 3002 (PERTH 04868765, 07013906); 23 Oct. 1996, *S. van Leeuwen* 2972 (PERTH 04868757, 07013256); 24 Oct. 1996, *S. van Leeuwen* 3010 (PERTH 07014880, 04608402); 17 Aug. 2001, *S. van Leeuwen* 4958 (PERTH 06765181); 6 Sep. 2002, *S. van Leeuwen* 5138 (PERTH 07478631); 8 Sep. 2002, *S. van Leeuwen* 5176 (PERTH 07478623).

Distribution. Currently known from only five populations fringing wetlands in the Little Sandy Desert. These populations are restricted to an area of approximately 530 sq km with 35 km between the most distant populations (Figure 6). The wetlands include Terminal and Yanneri Lakes on Ilgarari Creek and Beyondie Lakes on Nanyerinni Creek. These creeks and lakes are part of the Ilgarari Palaeoriver which joins the Disappointment Palaeoriver and forms part of the Lake Disappointment catchment (Beard 2005).

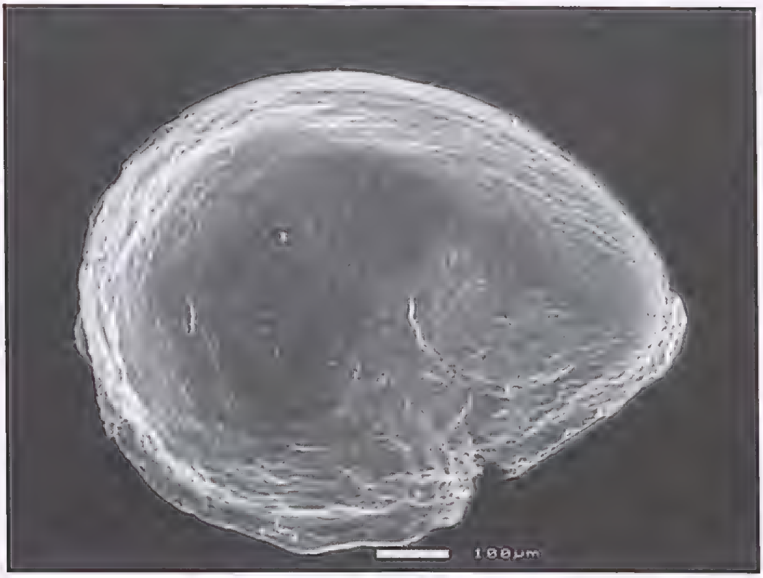

Figure 5: Environmental Scanning Electron Micrograph of a seed of *Tecticornia bibenda* (*K.A. Shepherd & C.F. Wilkins* KS 836). White scale bar = 100 µm.

Habitat. Low in the landscape near the edge of gypsiferous playas and salt lakes on flat to gently undulating terrain or on elevated gypsiferous and calcareous rims above playa basement. Soils red-brown saline sand with some clay over calcrete and gypsum (kopi) at depth. Growing in low heath to open dwarf scrub of *Melaleuca glomerata* and *M. xerophila* with *Lawrencia helmsii*, *Senna artemisioides, Eremophila glabra*, *Tecticornia* spp., *Scaevola collaris, Goodenia gypsicola*, over open low grass of *Eragrostis* spp. and *Aristida* spp. (Figure 2). Occasionally growing in deep red sand over gypsum forming an open heath over open hummock grasses of *Triodia schinzii* and *T. lanigera* with open tussock grass of *A. holathera*.

Phenology. Flowers from August to October. Fruits are retained on the plant for a year or more.

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. Currently there are five known populations represented by several thousand individuals, especially in the Terminal and Yanneri Lakes populations. Current threats to populations are mainly from trampling by camels and burning, especially for those plants growing in a sandy situation amongst spinifex hummocks. Future mineral exploration activity and the potential for the mining of gypsum may pose an increased threat to this species.

Chromosome numbers. Diploid counts of $2n = 18, 36$ were previously published for this species under *Halosarcia*. sp Yanneri Lake (S. van Leeuwen 3002) (Shepherd & Yan 2003).

Etymology. This species was nicknamed 'Michelin Man' because its large bulbous articles are reminiscent of the iconic 'Michelin Man' logo of Michelin Tyres. Michelin Tyres have given this character the Latin name Bibendum from the saying "Ad bibendum" (for drinking). The epithet for this species is derived from the name given to this character and is treated as an adjective.

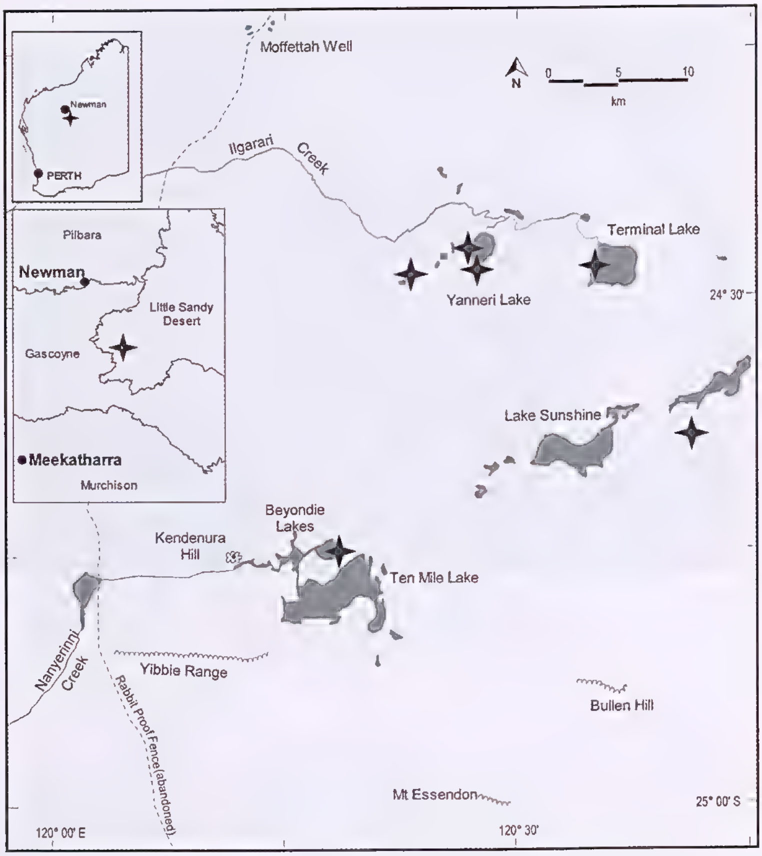

Figure 6: Distribution of *Tecticornia bibenda* with large inset showing the Interim Biogeographic Regionalisation for Australia (IBRA) categories.

Affinity. Molecular and morphological phylogenetic analyses indicate that *Tecticornia bibenda* is related to *T. indica* (Shepherd *et al*. 2004; Shepherd *et al*. 2005b). These species have similar flower and fruit morphology and a C_4 modified Kranz anatomy. *T. bibenda* is distinguished by the presence of very large and distinctive vegetative and fertile articles and having (4)5–7 flowers in each paired cyme rather than 3 which is typical for *T. indica* and almost all other species.

Notes. A possible hybrid between *T. indica* × *T. bibenda* was collected near Yanneri Lake (*K.A. Shepherd & C.F. Wilkins* KS 841) which has the same modified Kranz anatomy but smaller vegetative articles 5–12 mm long, 3–6.5 mm wide, shorter flowering spikes 10–21 mm long, 5.5–6.5 mm wide and only 3–4 flowers in each paired cyme. A phylogenetic analysis of molecular sequence data showed that this putative hybrid positioned between the parent species based on nuclear sequence data and placed sister to *T. bibenda* (as *H.* sp Yanneri Lake (S. van Leeuwen 3002)) in the chloroplast sequence analysis (Shepherd *et al.* 2004). This latter branch was supported with 69% Bootstrap support suggesting that while closely related, these two taxa were not identical. This supports the idea that this taxon is most likely a hybrid rather than a smaller form of *T. bibenda.*

The seeds of *Tecticornia bibenda* are gold brown in colour, smooth, and similar in shape to *T. indica* (Shepherd *et al.* 2005a) (Figure 5).

Acknowledgements

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Nuytsia 16(2):393–433 (2007)

A revision of the Western Australian genus *Agonis* (Myrtaceae) and two new segregate genera *Taxandria* and *Paragonis*

a235653

Judy R. Wheeler[1] and Neville G. Marchant[2,3]

[1]c/o Department of Environment and Conservation, 120 Albany Hwy, Albany, Western Australia 6330
[2]Western Australian Herbarium, Department of Environment and Conservation
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983
[3]Current address: Botanic Gardens and Parks Authority, Kings Park, West Perth 6005

Abstract

Wheeler, J.R. and Marchant N.G. A revision of the Western Australian genus *Agonis* (Myrtaceae) and two new segregate genera *Taxandria* and *Paragonis*: *Nuytsia* 16(2): 393–433 (2007). Two new genera, *Taxandria* (Benth.) J.R. Wheeler & N.G. Marchant (11 species) and the monotypic *Paragonis* J.R. Wheeler & N.G. Marchant are segregated from *Agonis* (DC.) Sweet *s. str.* (4 species). The three genera are revised; all are endemic to the south-west of Western Australia and together comprise 16 species. Two new species are described, two species reinstated and several new combinations and lectotypifications are made. Keys are provided to the three genera and their taxa. All taxa are illustrated and mapped.

Introduction

This paper presents a taxonomic revision of the genus *Agonis s. lat.* and describes the new genera *Taxandria* and *Paragonis*.

The name *Agonis* was first published by De Candolle (1828) for a section of *Leptospermum* J.R. & G. Forster. In this section De Candolle placed *L. flexuosa* (Willd.) Spreng., *L. marginata* Labill. and *L. linearifolia* DC. Sweet (1830) raised it to generic rank as *Agonis* (DC.)Sweet, as independently did Lindley (1839). G. Don (1832) also raised *Leptospermum* section *Agonis* to generic rank as *Billotia* R.Br. ex G.Don, which is therefore an illegitimate name (since it was based on the same sectional name) and a homonym of *Billottia* Colla (1824). Several species were described under either *Agonis* or *Billotia* prior to the treatment by Bentham (1867).

Bentham (1867) placed *Billotia* (as *Billiottia*) in synonymy with *Agonis* and divided the genus *Agonis* into two sections; section *Taxandria* Benth. in which the species have only 10 stamens (one opposite each sepal and one opposite each petal) and only 2 ovules in each cell of the ovary, and section *Ataxandria* Benth. [= *Agonis s. str.*] whose species have 20–30 stamens (usually grouped opposite the sepals with none opposite the petals) and 4–6 ovules in each cell of the ovary.

The current study recognises the two sections of Bentham as distinct genera. His section *Ataxandria* is recognised here as *Agonis* and his section *Taxandria* is raised to generic level. We also segregate *Agonis grandiflora* Benth. as a new monotypic genus *Paragonis*.

Some species of *Agonis* and *Taxandria* are very common in the south-west of Western Australia, forming extensive stands and understorey trees and shrubs. Several species, mostly those from the genus *Taxandria*, have generated much interest in the wildflower industry and are widely picked under licence in Western Australia. Others have also been the subject of intensive study for the production of essential oils and some have been very widely cultivated. *Agonis flexuosa* (Willd.) Sweet is cultivated in many parts of the world and a number of selected cultivars, many of them sterile, are available in the nursery trade.

Methods

Measurements are based on herbarium specimens from PERTH. The biogeographic regions listed for the distributions of the taxa follow Thackway & Cresswell (1995). Types were selected and obtained on loan from K, KW, LD, MEL and P as well as studied in Cambridge (CGE), Harvard (GH), St Louis (MO) and Wroclaw (WRSL).

The authors have undertaken extensive field work and all taxa have been studied *in situ.* Hybrids and presumed hybrids have also been studied and assessed in the field, using morphological characters and by identifying apparent parent taxa in the vicinity.

Similarities and differences between *Agonis*, *Taxandria* and *Paragonis*

Agonis s. lat. belongs in the *Leptospermum* suballiance of the Myrtaceae (Briggs & Johnson 1979) along with *Homalospermum* Schauer, *Leptospermum* J.R. & G. Forster and *Pericalymma* Schauer.

This current study of *Agonis s. lat.* recognises three genera, *Agonis* (DC.) Sweet, *Taxandria* (Benth.) J.R. Wheeler & N.G. Marchant and *Paragonis* J.R. Wheeler & N.G. Marchant. The main morphological differences between the three genera are shown in Table 1. The genus *Agonis s. str.*, previously recognised by Bentham as section *Ataxandria* [= sect. *Agonis*], is here redefined as a genus of trees or shrubs with alternate/spirally arranged simple leaves and a variable number of stamens, usually 15–30, rarely a few more, arranged in a single whorl with 3–6, rarely 7 of them opposite the sepals and none opposite the petals. It has a 3-celled ovary with 4–14 ovules per cell but only 1 or 2 of the ovules develop into fertile seeds, while the remainder wither or develop into angular infertile seeds.

The genus *Taxandria*, previously recognised by Bentham as section *Taxandria* within the genus *Agonis*, is segregated here as a genus of shrubs or occasionally trees with leaves spirally arranged with one at each node or in clusters. *Taxandria* species all have 10 stamens, one opposite each sepal and one opposite each petal. There are 2, rarely 3 ovules per cell of the ovary, but only 1 ovule per cell develops into a fertile seed.

Bentham (1867) recognised that *Agonis grandiflora* was anomalous in section *Ataxandria*, having its stamens in a complete ring instead of an interrupted ring with stamens all grouped opposite the sepals. This species is placed here in *Paragonis,* a monotypic genus of shrubs, characterised by spirally arranged leaves in clusters and a variable number of stamens, usually 22–35, in a continuous ring. Like *Agonis*, *Paragonis* has an ovary with more than two (3–6) ovules per cell, with usually only 1 developing to a seed, the remainder withering or producing angular infertile seeds.

Table 1. Comparison of morphological characters of *Agonis*, *Taxandria* and *Paragonis*.

Character	***Agonis***	***Paragonis***	***Taxandria***
Leaves	borne singly	clustered	often clustered
Inflorescence	dense clusters of many flowers	not clustered, 1–3 flowers together	dense clusters of many flowers
Bracts basal to inflorescence	inconspicuous	conspicuous	inconspicuous except *T. floribunda*
Flower diameter	5–15(20) mm	12–17 mm	3–9 mm
Sepal length	1–2.5 mm	2–3 mm	0.5–2 mm
Petal shape	basally gradually tapered	basally gradually tapered	distinctly and abruptly clawed
Stamen number	usually 15–30	22–35	10 rarely fewer
Stamen arrangement	3–6 or rarely 7 opposite each sepal	continuous ring	1 opposite each sepal and 1 opposite each petal
Staminal filament length	0.5–2 mm	2.5–4 mm	usually 0.3–1 mm (up to 1.5 mm in *T. floribunda*)
Ovule number	3–7(14) per cell	3–6 per cell	2(3) per cell

Table 2. Comparison of morphological characters with *Pericalymma, Homalospermum* and *Leptospermum*.

Character	***Agonis***	***Homalospermum***	***Leptospermum***	***Paragonis***	***Pericalymma***	***Taxandria***
Inflorescence	dense cluster of many flowers	single flowers	small clusters	1–3 flowers together	1–3 flowers together	dense cluster of many flowers
Bract & leaf transition	abrupt	abrupt	abrupt	abrupt	gradual	abrupt
Petals	somewhat persistent	not persistent	not persistent	not persistent	not persistent	long persistent
Stamens (grouping)	opposite sepals only	continuous ring	opposite petals only	continuous ring	continuous ring	opposite sepals and petals
Ovary (-celled)	3	4	mostly 3–5	3	3	3
Ovules	hemitropous, erect	hemitropous	anatropous	hemitropous, erect	hemitropous, spreading or pendulous	hemitropous, erect

The three genera presented in this paper differ from the genera *Pericalymma*, *Homalospermum* and *Leptospermum*, which have similar floral morphology, in a variety of characters depicted in Table 2. *Homalospermum* differs from *Agonis s. lat.* in having a 4-celled ovary with numerous hemitropous ovules, winged seeds and large single flowers formed on unmodified shoots. *Leptospermum* differs from *Agonis s. lat.* in having anatropous ovules and non-peltate seeds. *Agonis s. lat.* has hemitropous ovules and peltate seeds.

The genus *Pericalymma*, revised by Cranfield (1999), appears to be the most similar morphologically to *Agonis s. lat.* It is here considered to be distinct, differing in its flexuose dichotomous branchlets and its pendulous or spreading, rather than erect, ovules and seeds. *Pericalymma* also differs from *Agonis* and *Taxandria* in having an inflorescence bearing only 1–3 flowers together rather than a dense head of flowers and in its less persistent petals.

Independent support for the recognition of three separate genera came from the molecular data of O'Brien *et al.* (2000). Their phylogenetic analysis suggested one clade with *A. flexuosa* and *A. baxteri* (*Agonis s. str.*) and a second clade comprised the species with only 10 stamens (*Taxandria*) weakly linked to the genus *Pericalymma.* Their analysis recognised *A. grandiflora* (*Paragonis*) as being weakly linked to both *Taxandria* and *Pericalymma.*

O'Brien *et al.* (2000) postulated three generic scenarios: (1) combining *Agonis* and *Pericalymma*, (2) placing *A. grandiflora* with *Pericalymma* but retaining the remaining species of *Agonis* as one genus or (3) maintaining *Pericalymma* as it currently is but recognising segregate genera within *Agonis*. It is the last of these options that the present authors believe best fits the independent, morphological taxonomic study presented here.

Interspecific hybrids or probable hybrids have been detected to date in 8 of the eleven *Taxandria* and in 3 of the 4 *Agonis* species. It is highly likely that hybridisation and introgression are commonplace in these genera and have contributed to considerable morphological diversity in many taxa.

The following taxonomic study is based solely on morphological characters. Species are recognised where we have observed morphological discontinuities that we felt intuitively are at species level. Subspecies are also recognised on the basis of morphological discontinuities in characters such as leaf shape and apex and size of inflorescence and flower parts, correlated with geographic separation. Varieties are recognised on the basis of a lesser degree of morphological discontinuities and some degree of overlap in geographic distribution.

Taxa are arranged alphabetically within each genus. The descriptions take into account the majority of specimens available but there are some specimens which, because of their probable hybrid nature, are at variance with the species descriptions. Observed variations have been noted. All species have been examined in the field, and as mentioned previously, hybrids noted to date, have also been assessed in the field. Attention is drawn to assumed hybridisation in the notes under each species.

Taxonomy

Key to genera of *Agonis s. lat.*

1. Stamens 10 or rarely fewer at maturity, one opposite each sepal and one opposite each petal. Petals distinctly clawed with a circular limb .... **Taxandria**

1. Stamens 15–35, very rarely 11–14, in groups of 3–7 opposite each sepal or in a continuous ring. Petals spathulate to obovate and tapered gradually to their base

 2. Flowers and/or fruits in dense clusters, basal bracts subtending cluster usually inconspicuous. Sepals 1–2.5 mm long, densely hairy, not hooded. Stamens in groups opposite the sepals, none opposite the petals; filaments 0.5–2 mm long .... **Agonis**

 2. Flowers and/or fruits borne singly or 2 or 3 together, sub tended by several conspicuous and imbricate basal bracts. Sepals 2–3 mm long, glabrous, hooded. Stamens arranged evenly in the whorl; filaments 2.5–4 mm long .... **Paragonis**

Agonis (DC.) Sweet, Sweet's Hort. Brit. ed. 2, 209 (1830). – *Leptospermum* sect. *Agonis* DC., Prodr. 3: 226 (1828). – *lecto*: *Leptospermum flexuosum* (Willd.) Spreng. [≡ *Agonis flexuosa* (Willd.) Sweet.], *lecto: fide* ICBN 262 (2000)]. *Billotia* R. Br. ex G. Don, Gen. Hist. 2: 810, 827 (Oct. 1832) *nom. illeg.* – *Billottia* R. Br., *J. Roy. Geog. Soc.* 1: 19 (1832) *nom. nud.*; *lecto*: *Billotia flexuosa* (Willd.) G. Don.

?*Agonomyrtus* Schauer ex Reichb. *Handb.* 253 (1837) *nom. nud.*

Agonis sect. *Ataxandria* Benth., Fl. Austral. 3: 97 (1867). *Type:* since the lectotype of the genus *Agonis* was chosen subsequent to the description of *A.* sect. *Ataxandria*, it does not automatically become the lectotype of that section. The sectional name should therefore also be lectotypified on *A. flexuosa.*

Shrubs or *trees*. *Leaves* alternate to spirally arranged, single not clustered, exstipulate, sessile to petiolate, glandular-punctate, entire. *Inflorescence* of axillary globular heads of flowers with few to numerous inconspicuous basal bracts. *Flowers* bisexual, sessile, each subtended by a pair of bracteoles and below these a bract. *Floral tube* obconic but becoming cup-shaped, sometimes broadly so, adnate to the ovary, coriaceous, glandular-punctate. *Sepals* 5, ovate-triangular or triangular, hairy, persistent. *Petals* 5, usually white but frequently drying cream to yellow, spathulate to obovate and gradually tapered to the base, somewhat persistent. *Stamens* in a single whorl, free, (11–)15–30(–32), with 3–6(7) opposite each sepal, none opposite the petals; filaments linear to narrowly triangular; anthers ellipsoid to broadly ellipsoid, dorsifixed and versatile, with parallel cells, dehiscing by longitudinal slits; connective with a small globular gland. *Ovary* inferior, 3-celled; ovules 3–7(–14)per cell, erect. *Style* set in a depression at summit of ovary, terete; stigma capitate and disc-like, sometimes very shallowly lobed. *Infructescence* a globular cluster of fruits. *Fruit* a woody capsule formed from the ovary and surrounding floral tube, dehiscing by 3 valves. *Seeds* usually 1 or 2 per cell, grey to black, elliptic-obovoid, minutely papillose, very minutely apically winged; infertile seeds cream, angular to narrowly obovoid.

Size and distribution. A genus of 4 species endemic to the south-west of Western Australia.

Key to *Agonis* taxa

1. Infructescence 10–15 mm across. Leaves obovate or obovate-elliptic, (20–70 mm long and 7–20 mm wide), usually obtuse. Sepals 1.8–2.5 mm long. Petals 5–9 mm long .... **A. baxteri**

1. Infructescence 6-10 mm across. Leaves linear to narrowly elliptic (45–135 mm long and 3.5–12 mm wide), or elliptic to ovate or obovate (6-45 mm long and 4–8 mm wide), acute and sometimes shortly mucronate. Sepals 1–2 mm long. Petals 3–6 mm long

  2. Leaves slender, 45–135 mm long, not twisted or undulate, margin smooth and entire. 3–7 (usually 4 or 5) stamens opposite each sepal. Tree to 10 m tall .... **A. flexuosa** var. **flexuosa**

  2. Leaves broad, 6–45 mm long, often twisted and undulate, margin often minutely and irregularly indented. 2-5 (usually 3 or 4) stamens opposite each sepal. Shrub or small tree to 4 m tall

    3. Leaves 20–45 mm long, often slightly twisted................................**A. flexuosa** var. **latifolia**

    3. Leaves 6–20 mm long, distinctly twisted and undulate

      4. Sepals obtuse. Bracts and bracteoles obtuse. Leaves usually acute, the point often recurved ....**A. theiformis**

      4. Sepals narrowly-acute. Bracts and bracteoles narrowly-acuminate. Leaves usually emarginate .... **A. undulata**

Agonis baxteri (Benth.) J.R. Wheeler & N.G. Marchant, *comb. nov.*

Melaleuca baxteri Benth., Fl. Austral. 3: 138 (1867). *Type:* King George Sound or to the eastwards, [Western Australia], *Baxter* (*holo:* K *n.v.*, photograph seen).

Agonis obtusissima F. Muell., Fragm. 11: 119 (1881). *Type:* East Mount Barren, [Western Australia], *J. Drummond* 133 (*lecto:* PERTH 01605046, here designated; *isolecto:* K, KW, MEL 3321, P); Stokes Inlet, Cape Arid [Western Australia], G. Maxwell *s.n.* (*lectopara: n.v.*).

Shrub erect to 2 m high, often spindly and few-branched; branchlets glabrous or with sparse sericeous hairs and glabrescent. *Leaves* erect to spreading, with an indistinct petiole up to 10 mm long; blade narrowly obovate to obovate or elliptic, (20)25–55(70) mm long, (5)7–20 mm wide, flat, coriaceous, glabrous, with 3(5) longitudinal veins, the midrib with faint lateral pinnate veins, gradually tapered to base, entire, apex usually obtuse but occasionally subacute or emarginate. *Flower clusters* 15–25 mm across, with numerous grey-hairy sterile basal bracts. *Bract* circular or broadly to depressed obovate, 2.5–3.5 mm long, sericeous with dense grey hairs, apex obtuse. *Bracteoles* obovate and very slightly laterally curved, 2–3 mm long, 1.2–2 mm wide, densely grey-hairy except for the glabrous margins, apex obtuse. *Flowers* white-petalled drying cream, rarely very pale pink, 12–15(20) mm across. *Floral tube* 2.5–4 mm long, glabrous at base, sericeous with grey hairs in distal half, extended to 0.2 mm above the ovary. *Sepals* ovate-triangular to broadly ovate-triangular, 1.8–2.5 mm long, densely softly sericeous to villous with grey hairs, apex more or less obtuse. *Petals* 5–9 mm long. *Stamens* (17)23–32, with (3)4–6(7) opposite each sepal; filament 1–2 mm long; anther 0.2–0.3 mm long. *Ovary* summit glabrous; ovules 6–14 per cell. *Style* 2–3 mm long. *Infructescence* globular to broadly ellipsoid, 10–15 mm across. *Capsule* cup-shaped to turbinate, 4–5.5 mm across, shortly hairy in the distal half. (Figure 1A)

Selected specimens examined. WESTERN AUSTRALIA (all PERTH except where indicated): 0.5 km N of Mt Belches, 5 Oct. 1995, *R.J. Cranfield* 10489 (CANB *n.v.*); near the estuary of Duke Creek, Duke of Orleans Bay (Duke Creek is *c.* 65 km E of Esperance), Esperance District, Eucla Division, 2 Oct. 1968, *N.N. Donner* 2866 (AD *n.v.*); Inter [between] Israelite Bay et [and] Cape Arid, 21 Oct. 1960, *C.A. Gardner* 12915; Northern end of Thumb Peak Range, 31 Oct. 1965, *A.S. George* 7108; Whoogarup Range, 2 Dec. 1960, *A.S. George* 1898; East Mt Barren, 28 Oct. 1972, *G.J. Keighery* 2205; 1 km N of beachfront car park, Cape Le Grand, E of Esperance, 2 Oct. 1979, *N.G. Marchant* 79/82 (CANB; between Culham Inlet and Ravensthorpe-Hopetoun road to East Mt Barren, 3 Oct. 1979, *N.G. Marchant* 79/88; *c.* 1 km W of Rossiter Bay on road to Lucky Bay, Cape Le Grand National Park, 14 Oct. 1979, *K.L. Wilson* 2857 (NSW *n.v.*); *c.* 67 km E of Esperance, near Mungliginup Creek, 30 Sep. 1968, *P.G. Wilson* 8067.

Distribution. South West Botanical Province, IBRA region of Esperance Plains. Occurs in near-coastal areas, from the Fitzgerald River National Park and between Esperance and Israelite Bay. (Figure 2A)

Habitat. Occurs in heath or shrubland, sometimes on the edge of swamps or seasonally wet slopes, on sandy soils usually over granitic or quartzite rocks but with a single record from over coastal limestone.

Phenology. Flowers mainly October to December; mature fruits December onwards, the fruits persisting for 1 or 2 years.

Conservation status. Recorded as common in several localities and occurring in several national parks.

Typification. Mueller based *Agonis obtusissima* on two elements, Maxwell material with localities cited as "Stokes Inlet" and "Cape Arid" and a Drummond collection from East Mount Barren.

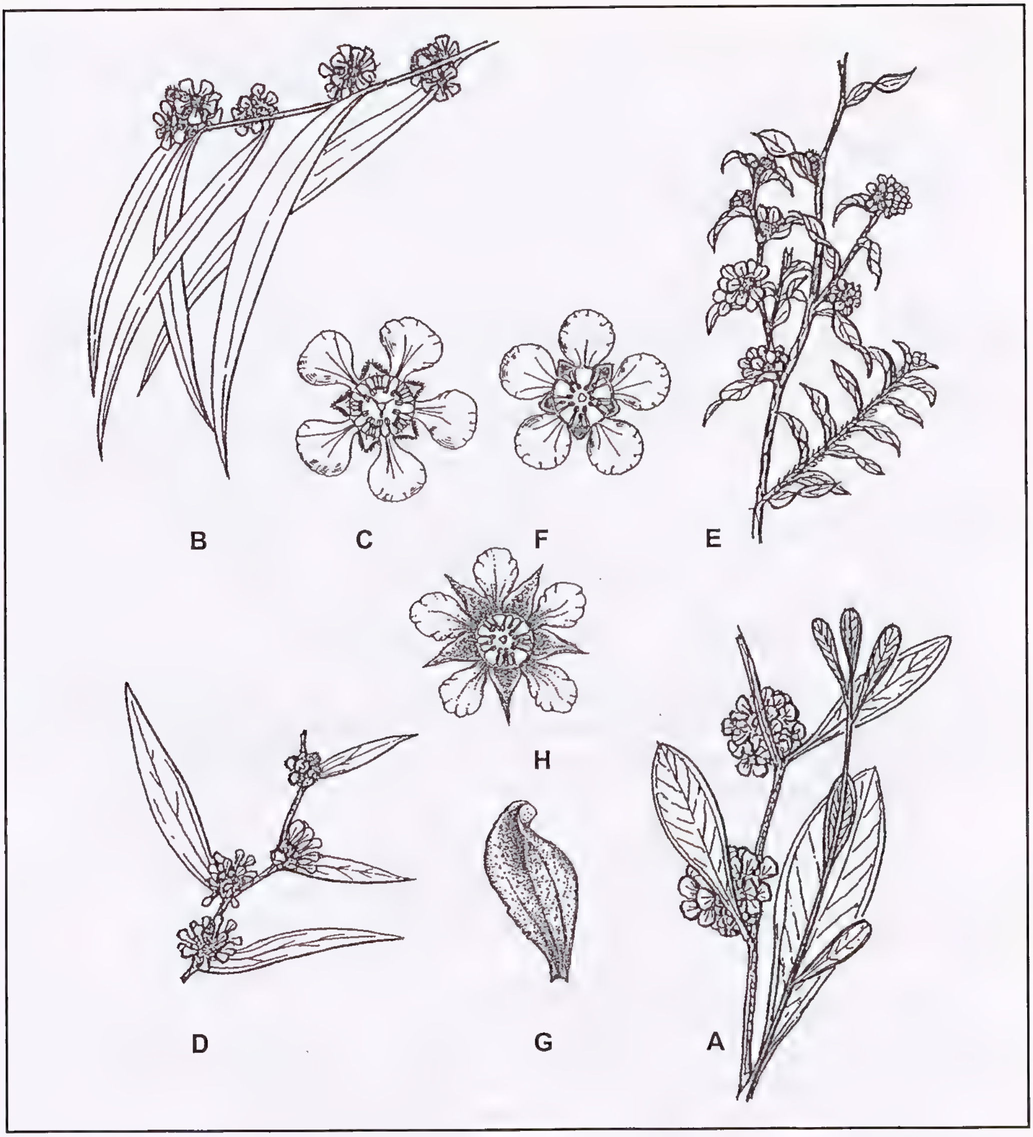

Figure 1. A – *Agonis baxteri* – flowering branch (×0.75); B, C – *Agonis flexuosa* var. *flexuosa*: B – flowering branch (×0.75), C – flower (×2); D – *Agonis flexuosa* var. *latifolia*, flowering branch (×0.75); E, F – *Agonis theiformis*: E – flowering branch, F – flower (×3); G, H – *Agonis undulata*: G – leaf (×2), H – flower (×3).

The Maxwell material has not been located. A specimen of *J. Drummond* 133 in MEL without locality details is regarded here as an isolectotype and the PERTH sheet of this collection, which has full locality details, is designated as the lectotype.

Affinities. Quite distinct from other species of the genus, it is characterised by its broad coriaceous leaves and large size of clusters, flowers and woody fruits.

Hybrids. No hybrids involving this species have been recorded.

Agonis flexuosa (Willd.) Sweet, Sweet's Hort. Brit. ed. 2, 209 (1830). – *Meterosideros flexuosa* Willd., Enum. Pl. Hort. Berol. 514 (1809). *Type:* 15 km along road from Dunsborough to Cape Naturaliste, 33° 36' 11" S, 115° 05' 53" E [Western Australia], small tree to 3m., flowers white, 02 Nov. 1978, *R.J. Cranfield* 931. (*neo:* PERTH 3882942, here designated; *isoneo:* MEL, NSW). – *Leptospermum flexuosum* (Willd.) Spreng., Novi provent. 25 (1818). – *Billotia flexuosa* (Willd.) G. Don, Gen. Hist. 2: 827 (1832). – *Billottia flexuosa* (Willd.) R. Br., *J. Roy. Geogr. Soc.* 1: 19 (1832). *Type:* "Habitat in Nova Hollandia" [Western Australia] (*n.v.*).

Tree to 10 m high, occasionally a wind-pruned mallee or tall to almost prostrate shrub; branchlets often flexuose, somewhat angular, sericeous but usually glabrescent. *Leaves* spreading, pendulous, sessile or with a petiole up to 5 mm long; blade very narrowly to narrowly elliptic or narrowly ovate, flat or somewhat twisted, sometimes falcate, 18–135 mm long, 3.5–12 mm wide, glabrous or sometimes with soft sericeous hairs but glabrescent, midrib prominent and usually 2 other longitudinal veins evident, lateral pinnate veins occasionally evident, base tapered or obtuse, margin smooth and entire or minutely and irregularly indented, apex acute. *Flower clusters* 10–15 mm across, basal sterile bracts few. *Bract* broadly ovate, circular or broadly obovate, 1.5(–2) mm long, densely sericeous, apex obtuse. *Bracteoles* narrowly elliptic to elliptic or obovate-elliptic, 1–1.5 mm long, 0.5–1 mm wide, densely sericeous on keel and towards the obtuse apex. *Flowers* white-petalled, often drying cream, 8–12 mm across. *Floral tube* 1.5–2 mm long, glabrous in lower two-thirds, sericeous in distal one-third, slightly extended for *c.* 0.5 mm above the ovary. *Sepals* ovate-triangular, 1–2 mm long, greyish sericeous, apex acute to subacute or obtuse. *Petals* spathulate-obovate, 3–6 mm long including an indistinct claw up to 1.5 mm long. *Stamens* (13–)20–25, 3–5 opposite each sepal but occasionally as many as 7 opposite some sepals, none opposite the petals; filament 1–1.5 mm long; anther 0.2–0.3 mm long. *Ovary* summit glabrous; ovules 5 or 6 per cell. *Style* 1–2.5 mm long. *Infructescence* globular, 6–10 mm across. *Capsule* broadly turbinate to broadly cup-shaped, 2.5–4 mm across, hairy in the distal part or sometimes glabrescent.

Two varieties are recognised.

a. Agonis flexuosa (Willd.) Sweet var. flexuosa

Billotia flexuosa var. *angustifolia* Otto & Dietr., *Allg. Gartenzeitung* 9: 218 (1841); *Agonis flexuosa* var. *angustifolia* (Otto & Dietr.) Schauer in Lehm., Pl. Preiss. 1: 117 (1844) – type not cited.

Tree to 10 m high or wind-pruned shrub; branchlets sometimes flexuose. *Leaves* very narrowly elliptic to narrowly elliptic, 45–135 mm long, more or less flat neither twisted nor undulate, midrib prominent but other longitudinal veins only faintly evident, base tapered, margin smooth and entire. *Sepals* acute to subacute. *Petals* 3–6 mm long. *Stamens* (3)4 or 5(7) opposite each sepal. *Capsule* 2.5–3.5(4) mm across. (Figure 1B,C)

Selected specimens examined. WESTERN AUSTRALIA (all PERTH except where indicated): Port Jackson (*sic*, provenance regarded here as an error), *Baudin* 1801 (P, GH); 41 km N of Augusta on Caves Rd, 26 Oct. 1983, *M.G. Corrick* 8932 (CBG, MEL, NSW all *n.v.*); 6 km S of Bremer Bay on Fisheries Rd, 1. Dec. 1985, *D.B. Foreman* 1388 (AD, CANB, HO, K, MEL, NSW all *n.v.*); Mt

Frankland Rd, *c.* 22 km N of Walpole, 5 km E of Thompsons Rd, 5 Dec. 1985, *D.B. Foreman* 1493 (CANB, MEL, NSW all *n.v.*); Swan River, *Fraser* 54 (GH); Northcliffe Forest Park, 7 Dec. 1990, *L. Graham* 576; Barlee Brook, 30 km S of Nannup, 11 Sep. 1981, *W. Greuter* 18010; Campbell Rd, Denmark Shire, 13 Oct. 1991, *B.G. Hammersley* 570; Locke Nature Reserve, W of Vasse, 18 Oct. 1994, *G.J. Keighery* 14844 (CANB *n.v.*); SW corner of Mt Brown (Beeliar) Regional Park beside Cockburn Rd, 10 Nov. 1997, *L.W. Sage s.n.*; Albany, 8 Oct. 1971, *V. Scarth-Johnson* 936 (BRI *n.v.*); Cape Naturaliste, 5 Nov. 1974, *D.J.E. Whibley* 5026 (AD *n.v.*); Southern Estuary Rd, S of Mandurah, *c.* 30 km N junction to Old Bunbury Rd, 19 Oct. 1994, *A. Worz* 04.10.19.02.

Distribution. South West Botanical Province, IBRA region of Swan Coastal Plain, Warren, Jarrah Forest and Esperance Plains (western part). Common in near-coastal areas from Perth to Bremer Bay. (Figure 2B)

Habitat. Occurs in varied habitats from coastal heath to woodland or jarrah and karri forest, on sandy, loamy or clayey soils over granitic or limestone rocks.

Phenology. Flowers mostly September to December; fruits December onwards, the fruits persisting at least a year.

Conservation status. A very widespread and common species occurring in several national parks.

Typification. An extensive search for the Type of *Metrosideros flexuosa* Willd. has not been successful. Willdenow described this species from an immature cultivated specimen that he recorded as being 10 feet tall and with pendulous branches. The origin of the seed is uncertain; as it was probably collected prior to about 1809 it could have originated from Geographe Bay or King George Sound.

It seems very likely that it was based on the common, weeping *Agonis flexuosa* accepted here as the typical form and not *Agonis flexuosa* var *latifolia* that to date has only been recorded from the south coast. The authors have chosen a specimen from the Busselton-Cape Naturaliste area as a neotype.

Affinities. Agonis flexuosa var. *flexuosa* is a quite distinctive and relatively widespread taxon.

Hybrids. Possible hybrids have been noted between *A. flexuosa* var. *flexuosa* and *A. flexuosa* var. *latifolia* in populations where both varieties occur at William Bay and near Walpole.

Notes. A number of horticultural varieties of *Agonis flexuosa* have arisen in cultivation and have been selected for propagation. Others have arisen in nature, possibly the result of hybridisation between variants of *A. flexuosa* and morphologically similar taxa.

The horticultural variants have the general appearance of the typical variety except in habit, leaf colour and leaf shape but appear to be mostly non-flowering. Some cultivars have distinctly flexuose small branches, others may mature into low, spreading trees with right-angled branches. A few of the common cultivars are: *Agonis* 'Belbra Gold', *Agonis* 'Nana', and *Agonis* 'Fairy Foliage'.

b. Agonis flexuosa var. **latifolia** (Otto & Dietr.) Schauer in Lehm., Pl. Preiss. 1: 117 (1844). – *Billotia flexuosa* var. *latifolia* Otto & Dietr., *Allg. Gartenzeitung* 9: 218 (1841) – type not cited. *Type:* "In solo turfoso arenoso ad Stirling's Terrace (Plantagenet)" [Albany, Western Australia], September 1840, *Preiss* 144 (*neo:* LD; *isoneo:* K, KW, MEL 21 & 22, MO, NY, P).

Shrub or small tree to 4 m tall; branchlets commonly flexuose. *Leaves* usually narrowly ovate, 18–45 mm long, often somewhat twisted, midrib and two longitudinal veins usually evident, base obtuse, margin sometimes minutely and irregularly indented. *Sepals* obtuse to subacute. *Petals* 3–4 mm long. *Stamens* 3 or 4 opposite each sepal. *Capsule* 3–4 mm across. (Figure 1D)

Selected specimens examined. WESTERN AUSTRALIA (all PERTH except where indicated): Walpole–Nornalup National Park, Point 31, 20 Nov. 1987, *A.R. Annels* 81; without locality, undated, *J. Drummond* 77 (NY, P); Denmark Shire, Lights Rd, below S face of Mt Hallowell, 13 Oct. 1991, *B.G. Hammersley* 563; E boundary of William Bay National Park, 17 Oct. 1992, *B.G. Hammersley* 725; Bakers Spring, Stirling Ranges, 13 May 1982, *G.J. Keighery* 4981; Lake Williams, William Bay National Park, 13 Aug. 1991, *C.J. Robinson s.n.*; Two Peoples Bay Reserve, S point, Eyre Botanical District, 24 Oct. 1994, *L. Sweedman* S3504; Near plot 5455, W of Betty's Beach on Two Peoples Bay, Boulder Hill, 2 May 1992, *G. Wardell-Johnson* 107; 5.5 km SE of Manypeaks town site, 4 May 1993, *G. Wardell-Johnson* 3216; Walpole–Nornalup National Park, near Isle Rd junction with South West Highway, 15 Oct. 1991, *J.R. Wheeler* 2733; Cheyne Beach, 22 Feb. 1994, *J.R. Wheeler & N.G. Marchant* JRW 3897.

*Distribution***.** South West Botanical Province, IBRA regions of Warren, Jarrah Forest and Esperance Plains. Occurs from west of Walpole to Cheyne Beach, with a population recorded from the Stirling Range. (Figure 2C)

Habitat. Recorded mainly from sandy soils in heath, shrubland or woodland.

Phenology. Flowers September to November; fruits December onwards, the fruits persisting at least until the next season.

Conservation status. Widespread and occurring in several national parks.

Typification. Since there is no evidence of any extant type material for the basionym *Billotia. flexuosa* var. *latifolia*, a neotype has been selected. Of the several specimens seen of *Preiss* 144, the LD specimen is chosen as the neotype as it is the one most likely to have been seen by Schauer.

Affinities. Agonis flexuosa var. *latifolia* differs from var. *flexuosa* in its smaller leaves and usually fewer stamens and from *A. theiformis* in its slightly larger less twisted leaves in which the margins are only sometimes minutely and irregularly indented. The variety may be the result of hybridisation between *Agonis flexuosa* and *A. theiformis*. However *A. flexuosa* var. *latifolia* seems to be relatively morphologically consistent and fertile. It has been known from 1840, before agricultural and road-making disturbances. As this taxon is very similar to the typical variety and they often grow together it is recognised here at varietal level.

Hybrids. A range of variants between *A. flexuosa* var. *flexuosa*, *A. flexuosa* var. *latifolia* and *A. theiformis* have been examined by the authors east of Albany indicating a hybrid swarm with introgressants tending to resemble *A. flexuosa* var. *latifolia* (*J.R. Wheeler & N.G. Marchant* JRW 3897 & 3898). Possible hybrids have also been noted between the two varieties of *A. flexuosa* at other localities (see note under *A. flexuosa* var. *flexuosa).*

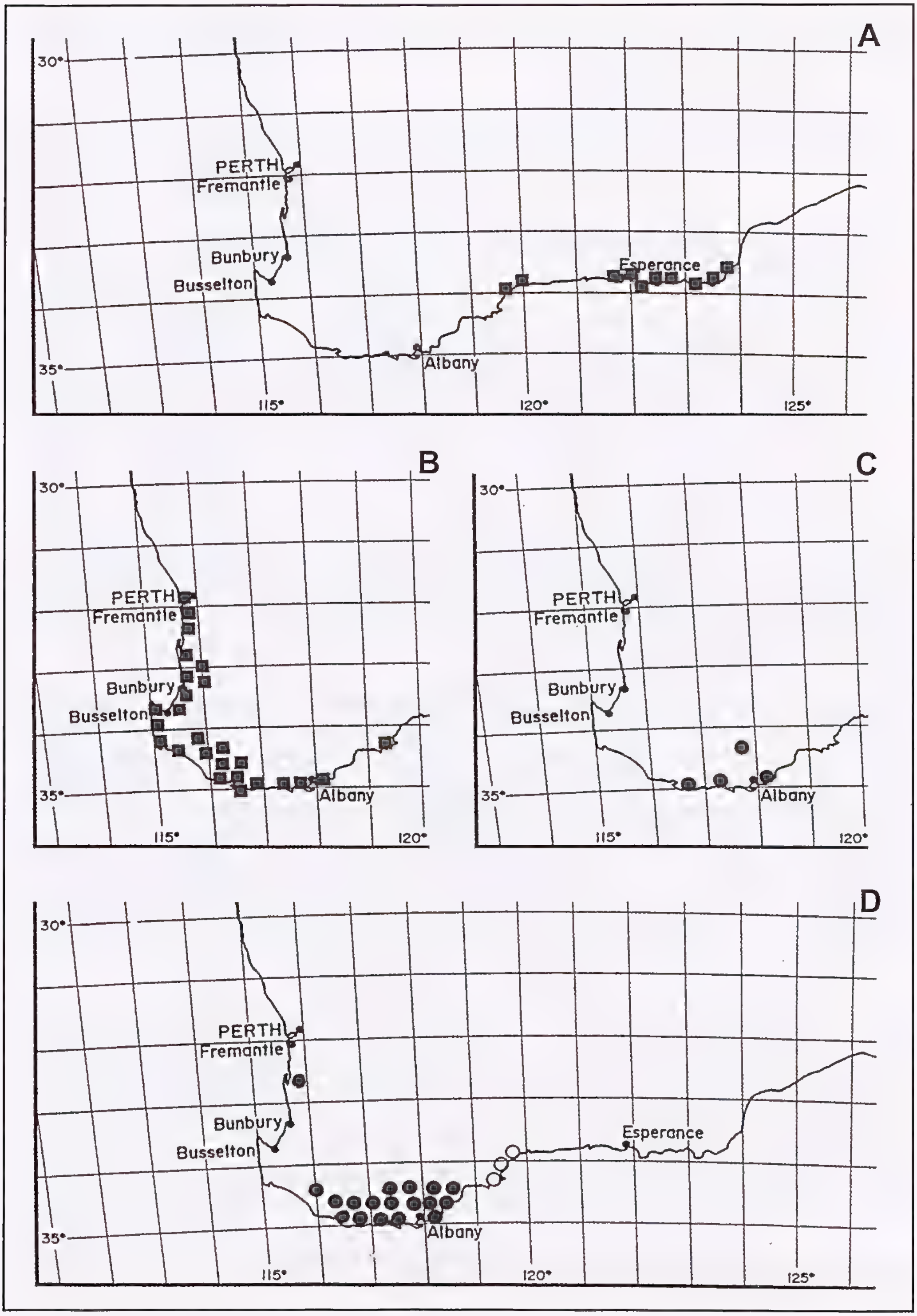

Figure 2. Distribution maps for *Agonis*. A – *A. baxteri*; B – *A. flexuosa* var. *flexuosa*; C – *A. flexuosa* var. *latifolia*; D – *A. theiformis* ● and *A. undulata* ○.

Agonis theiformis Schauer in Lehm., Pl. Preiss. 2: 223 (1848) [as *theaeformis*]. – *Billotia theaeformis* (Schauer) G. Don ex Loudon, Encycl. Pl. Suppl. 2, 1380 (1855). *Type*: "in subturfoso-arenosis circe urbisculam Albany", [Western Australia], 21 December 1840, *Preiss* 153 (*lecto:* LD, here designated; *isolecto:* K, KW, MEL 3304, 3305, P).

[*Agonis hypericifolia auct .non* (Otto & Dietr.) Schauer: Schauer in Lehm., Pl. Preiss. 1, 117 (1844). Misapplication of the name *Leptospermum hypericifolium* Otto & Dietr., *Allg. Gartenzeitung* 9: 243 (1841).]

Shrub to 2(3) m high, often somewhat spindly; branchlets sometimes flexuose, with short to long appressed to erect hairs, glabrescent. *Leaves* sessile or subsessile, elliptic to ovate and sometimes broadly so, undulate and twisted, sometimes somewhat recurved in distal half, 6–20 mm long and 4–10 mm wide, upper surface glabrous or almost so, lower surface with sparse soft hairs, midrib prominent, often with faint pinnate lateral veins, base truncate, obtuse or cordate, margin sometimes with minute irregular indentations, apex usually acute, usually shortly mucronate. *Flower clusters* 7–11 mm across, sterile basal bracts few. *Bract* broadly to very broadly ovate or obovate, 1.3–2 mm long, densely sericeous, ciliolate, apex obtuse. *Bracteoles* ovate or elliptic to obovate, often broadly so, 1–2 mm long and 1–1.5 mm wide, densely sericeous, ciliolate, apex obtuse. *Flowers* white-petalled, often drying cream to pale yellow, 5–8 mm across. *Floral tube* 1–2 mm long, sericeous, extending for *c.* 0.5 mm above the ovary. *Sepals* ovate-triangular, 1–1.5 mm long, hairy but the margin more or less glabrous and ciliolate, apex obtuse. *Petals* 2.5–4 mm long including an indistinct claw up to 0.5 mm long. *Stamens* (11–)15–20, (2)3 or 4 opposite each sepal; filament 0.7–1.5 mm long; anther *c.* 0.3 mm long. *Ovary* summit glabrous; *ovules* 4–7 per cell. *Style* 0.7–1.5 mm long. *Infructescence* globular, 6–8 mm across. *Capsule* cup-shaped to very broadly turbinate, 3.5–4 mm across, shortly hairy to glabrous. (Figure 1E,F)

Selected specimens examined. WESTERN AUSTRALIA (all PERTH except where indicated): Spencer Rd Reserve, 12 km W of Narrikup, 15 Nov. 1986, *E.J. Croxford* 5467; behind the Ranger's cottage, Porongurup Range, 19 Nov. 1983, *D. Davidson s.n.*; Top of Sukey Hill, 3 km E of Cranbrook, 10 Dec. 1996, *R. Davis* 1695; *J. Drummond* 3: 41 (NY, P); Mt Frankland Rd, *c.* 22 km N of Walpole, 5 km E of Thompson Rd, 5 Dec. 1985, *D.B. Foreman* 1495 (CANB, MEL both *n.v.*); S end of Lake Muir, Lake Muir Nature Reserve, 27 Oct. 1997, *G.J. Keighery & N. Gibson* 2649; Valley of the Giants Rd, *c.* 14 km E of Walpole, 25 Oct. 1997, *B.J. Lepschi & B.A. Fuhrer* BJL 3674; upper slopes of Toll Peak, Chester Pass, Stirling Range, 6 Dec. 1979, *N.G. Marchant* 79/106 (CANB *n.v.*); Reserve 13240, Cheyne Bay, N of Cape Riche, 24 Oct. 1996, *J.W. Mercer* 72; South West, Plantagenet, Nov. 1901, *E. Pritzel* 927 (GH, P, WRSL); Mt Manypeaks, 10 Oct. 1961, *H. Seddon s.n.*; 60 km NE of Albany on road to Jerramungup, 10 Nov. 1974, *D.J.E. Whibley* 5220 (AD *n.v.*).

Distribution. South West Botanical Province, IBRA regions of Warren, Jarrah Forest, Swan Coastal Plain, Avon and Esperance Plains. Occurs from Northcliffe and Shannon to Cheyne Bay (north of Cape Riche) extending inland to the Stirling Range, with a doubtful record from Pinjarra (*W.E. Blackall s.n.*). (Figure 2D)

Habitat. Occurs in a variety of vegetation types from heath, shrubland and forest, on a variety of soil types from sand, loam or clay soils over laterite, granite or limestone.

Phenology. Flowers October to December; fruits December to February, old fruits persisting at least until the following season.

Conservation status. Widespread and often quite common.

Typification. Of the syntypes examined (*Preiss* 152 and 153; *Cunningham* 1822), *Preiss* 153 has been distributed to several herbaria. The LD specimen is chosen as the lectotype as it is the one most likely to have been seen by Schauer.

Nomenclatural notes. The epithet of this species has been corrected from the original "*theaeformis*" to "*theiformis*" in accordance with Article 60.8 of the International Code of Botanical Nomenclature (McNeill *et al.* 2006).

Affinities. Easily confused with *Agonis undulata,* the two with similar foliage, stamens and petals but this species has distinctly obtuse bracts, bracteoles and sepals. *A. undulata* has acute sepals and distinctive long-acuminate bracts and bracteoles.

Hybrids. Possible hybrids have been recorded with *Agonis flexuosa* var. *latifolia* at Cheyne Beach (*J.R. Wheeler & N.G. Marchant* JRW 3897 and 3898). See note under that taxon.

Agonis undulata Benth., Fl. Austral. 3: 100 (1867). *Type:* Western Australia, *Drummond* 6 (*holo:* K).

Shrub to 2 m high, mature plants usually with thick gnarled branches; branchlets almost glabrous, sometimes with a few tiny appressed hairs below the leaf bases. *Leaves* erect, not or scarcely spreading, subsessile to indistinctly petiolate, obovate and somewhat undulate, 9–20 mm long and 4–10 mm wide, glabrous and 1-veined or faintly 3–5-veined, margin with minute irregular indentations, apex emarginate or occasionally with an acute recurved mucro in the sinus of the emarginate apex. *Flower clusters* 7–10 mm across, a vegetative shoot later continuing to grow from the inflorescence axis. *Bract* ovate, 2.5–3 mm long, somewhat ribbed and with sparse appressed hairs towards the centre in the lower half, tapered to a very long-acuminate apex. *Bracteoles* ovate-elliptic, *c.* 2.5 mm long and *c.* 2 mm wide, keeled, densely hairy down the keel but otherwise glabrous, apex long-acuminate. *Flowers* white-petalled, 5–8 mm across. *Floral tube* obconic, 1.7–2 mm long, appressed-hairy, extended for 0.5 mm above the ovary. *Sepals* triangular, 2–2.5 mm long, appressed-hairy, long-acute. *Petals* 2–2.5(–3) mm long, gradually tapered to the base. *Stamens* 15–20, 3 or 4 opposite each sepal; filament 0.5–1 mm long; anther *c.* 0.3 mm long. *Ovules* 4 per cell. *Style c.* 1.5 mm long. *Infructescence* globular, 8–10 mm across., occasionally those of successive years formed above one another forming a cylindric but interrupted spike 30–40 mm long. *Capsule* broadly cup-shaped to broadly turbinate, 4–5 mm across, somewhat hairy. (Figure 1G,H)

Other specimens examined. WESTERN AUSTRALIA (all PERTH): Thumb Peak, Barren Range, 10 Jan. 1996, *S. Barrett* 425; quartzite outcrop above St Marys Inlet gorge, Fitzgerald River National Park, 29 Apr. 1996, *N. Brown* 250/96; Mt Bland, Fitzgerald River National Park, 15 July 1970; *A.S. George s.n.*; Thumb Peak, E of Albany, 28 Oct. 1967, *K.R. Newbey* 2658; 2.2 km NE of Quoin Head, Fitzgerald River National Park, 26 Mar. 1987, *K.R. Newbey* 11528; Fitzgerald River National Park, West Mt Barren, upper eastern slopes, 6 Sep. 2001, *J.R. Wheeler* 4079; Fitzgerald River National Park, West Mt Barren, eastern slopes, 6 Sep. 2001, *J.R. Wheeler* 4080; Fitzgerald River National Park, Point Ann Rd, 4.2 km W of Trigelow Beach turn-off and 8.6 km SE of Collets Rd, 7 Sep. 2001, *J.R. Wheeler* 4092.

Distribution. South West Botanical Province, IBRA region of Esperance Plains. Restricted in distribution, recorded only from Fitzgerald River National Park. (Figure 2D)

Habitat. In shrubland or heath, from rocky or skeletal sands, often in areas of outcropping quartzite.

Phenology. Flowers spasmodically, recorded for September and March, the petals soon shed; fruits persisting for several years.

Conservation status. Conservation Codes for Western Australian Flora: Priority Three. Although restricted, the species occurs at a number of sites in a large national park and was found to be quite common at two sites.

Affinities. Most similar to *Agonis theiformis*, but bracts, bracteoles and sepals of *A. theiformis* are all shorter and distinctly obtuse. The leaves of *A. theiformis*, although similar to those of *A. undulata*, are more spreading, ovate-elliptic in shape and with an acute recurved apex, rarely emarginate.

Hybrids. No hybrids have been recorded involving this species.

Notes. *Agonis undulata* has previously been confused with *A. theiformis* until a study was made of the type specimen and material in PERTH was re-examined. Blackall & Grieve (1980) recognised both species, assuming that *A. undulata* occurred in the Stirling Range and coastal areas of the Stirling District between Albany and the Beaufort Inlet west of Bremer Bay. *A. undulata* occurs to the east of *A. theiformis,* in the western part of the Fitzgerald River National Park.

Nomina dubia

Leptospermum resiniferum Bertol., *Opusc. Sci.* 1: 148 (1817),. *Type:* "*Eucalyptus resiniferum* Hort. Ital. Frut. Habitat in Nova Hollandia". Type not seen, possibly a synonym of *Agonis flexuosa* as indicated by Bentham (1867) and Thompson (1989).

Leptospermum glomeratum Wendl. Flora 2: 678 (1819). *Type:* "in Nova Hollandia" . Type not seen, but placed as a synonym of *Agonis flexuosa* by Bentham (1867).

Taxandria (Benth.) J.R. Wheeler & N.G. Marchant, *stat. et gen. nov.*

Agonis sect. *Taxandria* Benth., Fl. Austral. 3: 97 (1867). – *Agonis* sect. *Billotia* Kuntze *nom. illeg.* [= sect. *Taxandria*], Lex. Gen. Phan. 14 (1903). *Lecto* (here designated): *Agonis marginata* (Labill.) Schauer [= *Taxandria marginata* (Labill.) J.R. Wheeler & N.G. Marchant].

Shrubs or *trees*. *Leaves* spirally arranged, single or in clusters, exstipulate, glandular-punctate, entire. *Inflorescence* usually of globular to ellipsoid heads of flowers, each flower subtended by a pair of bracteoles and below these a bract, further outermost bracts usually sterile and inconspicuous, the heads hemispherical in bud, the shoots often continuing to grow after flowering. *Flowers* bisexual, sessile. *Floral tube* obconic, sometimes broadly so, coriaceous, glandular-punctate, adnate to the ovary but extending very slightly to distinctly beyond the ovary. *Bracts* concavo-convex. *Bracteoles* concavo-convex, usually slightly to distinctly laterally curved. *Sepals* 5, ovate-triangular or triangular, glabrous to densely hairy, persistent. *Petals* 5, usually white (rarely pale pink) but sometimes tinged pink in bud, remaining white when dry, distinctly clawed and with a circular limb, long-persistent. *Stamens* in a single whorl, free, 10 (rarely fewer by abortion), one opposite each sepal and one opposite each petal; filaments linear to narrowly triangular, those opposite the petals often slightly longer; anthers ellipsoid to broadly ellipsoid with parallel cells, dorsifixed and versatile, dehiscing by longitudinal slits; connective with a small globular gland. *Ovary* inferior, 3-celled; ovules 2(3) per cell, erect. *Style* terete, set in a deep depression at the summit of the ovary; stigma capitate and disc-like, sometimes very shallowly lobed. *Infructescence* a globular to ellipsoid cluster of fruits, long-persistent. *Fruit* a woody capsule formed from the ovary and surrounding floral tube, dehiscing by 3 valves. *Seeds* usually only one developing per cell, red-brown to black, obovate-elliptic, papillose, minutely apically winged; infertile seeds cream, angular to narrowly obovoid.

Size and distribution. A genus of 11 species endemic to the south-west of Western Australia.

Lectotypification. Of the six species included in section *Taxandria* by Bentham (1867), *A. marginata* is chosen as the lectotype because it was the first member of the group to have been formally named. It was originally described by Labillardiere in 1806 as a species of *Leptospermum.*

Notes. There are many possible hybrids between species of *Taxandria* with resultant difficulty in circumscribing taxa and thus identifying some specimens.

Taxandria floribunda is unusual in the genus because of its prominent sterile basal bracts forming an involucre around each flower cluster.

Key to *Taxandria* taxa

1. Flower clusters surrounded by conspicuous and persistent involucral bracts that surround the fruits (Cranbrook and Stirling Ranges) .... **T. floribunda**
1. Flower clusters lacking conspicuous involucral bracts
  2. Leaves usually somewhat recurved in distal half. Bracteoles obtuse to emarginate
    3. Leaves 2–6.5 mm long and 0.6–1.5 mm wide. Sepals 0.5–1(–1.2) mm long, glabrous or sparsely hairy. Bracteoles up to 2 mm long
      4. Leaves sessile, narrowly obovate to narrowly elliptic, much longer than broad. Bract emarginate (Bunbury to Two Peoples Bay).......................... **T. parviceps**
      4. Leaves petiolate, very broadly spathulate-obovate to very broadly elliptic, often scarcely longer than broad. Bract very obtuse (Lake King to Israelite Bay).. **T. spathulata**
    3. Leaves 6–14 mm long and (2–)3–6 mm wide. Sepals 1–1.7 mm long, densely hairy at least in distal half. Bracteoles more than 2 mm long (Augusta to Denmark) .... **T. inundata**
  2. Leaves more or less straight, not recurved in distal half. Bracteoles usually obtuse or acute (obtuse to emarginate in *T. fragrans*)
    5. Leaves broad, less than 3 times longer than wide
      6. Leaves obtuse, distinctly petiolate
        7. Leaves 9–28 mm long, usually with a distinct fringe of marginal hairs even when mature. Sepals densely hairy (Walpole to Cheyne Beach and Esperance to Israelite Bay)... **T. marginata**
        7. Leaves 2–6 mm long, glabrous apart from marginal hairs when young. Sepals with sparse coarse hairs and ciliolate margins (Lake King to Israelite Bay).. **T. spathulata**
      6. Leaves acute and bluntly mucronate, usually with a poorly defined petiole (Fitzgerald River and Mt Ragged) ...... **T. conspicua** subsp. **abrupta**

5. Leaves narrow, more than 3 times longer than wide
  8. Bracteoles small, narrow and distinctly laterally curved, 0.3–0.8(–1) mm wide. Sepals obtuse to subacute, usually quite densely hairy to almost glabrous
    9. Leaves linear, the upper surface conspicuously concave. Sepals subacute to obtuse, often almost glabrous (Ravensthorpe to Cape Paisley)............... **T. callistachys**
    9. Leaves linear to obovate-elliptic flat to shallowly concave above. Sepals obtuse, usually quite densely hairy
      10. Leaves flat or almost so. Flowers 3–5 mm across. Shrub or tree of watercourses (South west to Mt Manypeaks).. **T. linearifolia**
      10. Leaves slightly concave above. Flowers 5–9 mm across. Shrub of heath, shrubland or granitic outcrops
        11. Leaves narrowly elliptic to narrowly elliptic-obovate and gradually tapered at each end. Granitic outcrops (Busselton to Albany)... **T. conspicua** subsp. **conspicua**
        11. Leaves usually obovate to obovate-elliptic and abruptly tapered at each end. Shrub of a variety of soils in heath or shrubland (Fitzgerald River and Mt Ragged)............... **T. conspicua** subsp. **abrupta**
  8. Bracteoles scarcely to very slightly laterally curved, 1 mm or more wide. Sepals acute, glabrous or with fairly sparse hairs
    12. Leaves widely spreading and somewhat rigid. Bracteoles 1.8–4 mm wide, obtuse to emarginate (Margaret River to Albany).................. **T. fragrans**
    12. Leaves ascending to slightly spreading, fairly soft. Bracteoles 1–2.7 mm wide obtuse to acute or acuminate
      13. Shrub. Leaves 10–23 mm long, distinctly concave above and convex below. Sepals glabrous or some with fairly sparse hairs (West Cape Howe to Cheyne Beach).. **T. angustifolia**
      13. Tree. Leaves 7–13 mm long, usually flat to very slightly concave above and convex below. Sepals glabrous (Augusta to Waychinicup) .... **T. juniperina**

Taxandria angustifolia (Schauer) J.R. Wheeler & N.G. Marchant, *comb. nov.*

Agonis angustifolia Schauer in Lehm. Pl. Preiss. 1: 118 (1844). *Type*: "In rupestribus summitatis montis Wuljenup (Plantagenet)", [Mt Willyung, Western Australia], 13 October 1840, *Preiss* 149 (*lecto:* LD, here designated; *isolecto:* MEL 3376, 3377, MO).

Agonis glabra Turcz., *Bull. Cl. Phys.-Math. Acad. Imp. Sci. Saint-Petersbourg* 10: 334 (1852). *Type:* [Western Australia], *Drummond* V: n. 132 (*holo:* KW; *iso:* K).

Shrub, erect to 3.5 m high, often quite dense; branchlets usually glabrous, occasionally with appressed hairs. *Leaves* single or sometimes clustered in short axillary shoots, subsessile, linear, (8–)10–23 mm long, 0.6–1.2(–1.5) mm wide, thick and concave above and convex below, almost glabrous but often with appressed hairs towards the base of the upper surface, midrib evident only towards the base of the lower surface, base cuneate, margin with appressed hairs especially towards the base, apex acute and mucronate. *Flower clusters* usually axillary but sometimes terminating short shoots, hemispherical to globular, 6–10 mm across, sterile basal bracts few. *Bracts* ovate or occasionally oblong-elliptic, 1.5–3(–4) mm long, somewhat keeled, glandular-punctate and somewhat verrucose but margins thinner and smooth, glabrous or hairy particularly on the keel, apex shortly acute to acuminate. *Bracteoles* elliptic to obovate-spathulate, 1.5–2.5(–3) mm long, (0.9–)1–2(–2.5) mm wide, not or only slightly laterally curved, glandular-punctate and somewhat verrucose but margins thinner and smooth, glabrous or hairy especially towards the apex and along the keel, apex acute, or obtuse and shortly acuminate to long-acuminate. *Flowers* 5–8 mm across. *Floral tube* obconic, 1–2 mm long, glabrous or minutely hairy, slightly extended for up to 0.5 mm above the ovary. *Sepals* triangular, 1–1.5(–2) mm long, shortly acute to long-acute but occasionally subacute, usually glabrous but quite often with fairly sparse spreading or appressed hairs. *Petals* 2–3(–3.5) mm long including the claw of *c.* 0.5 mm long. *Stamens:* filament 0.5–0.8 mm long; anther 0.2–0.3 mm long. *Ovary* summit glabrous; ovules 2 per cell. *Style* 1–1.5 mm long. *Infructescence* globular and 6–10 mm across or ellipsoid and up to 15 mm long. *Capsule* ovoid, 2–3 mm across, glabrescent or puberulous. (Figure 3A–E)

Selected specimens examined. WESTERN AUSTRALIA (all PERTH except where indicated): Porongurup, Sep. 1995, *A. Burchell* 95/3; Gull Rock Rd, above beach turnoff, 10 June 1979, *E.J. Croxford* 351; N side of Peak Head, 27 July 1981, *D. Davidson* 55; Mt Manypeaks, N base of second peak from E, 15 Oct. 1984, *D. Davidson s.n.*; Cheyne Beach near caravan park, 20 Mar. 1997, *R. Davis* 2955; Mt Gardner, E of Albany, 29 May 1964, *A.S. George* 6309; N side of Moyle Rd, near Two Peoples Bay Rd junction, Two Peoples Bay Nature Reserve, 1 May 1992, *N. Gibson & M. Lyons* 761; 9 km direct NNW of Albany at Willyung Hill, SW side below trig., 2 Nov. 1992, *A.M. Lyne* 969, *Craven & Zich* (AD, BRI, CBG, MEL, NSW all *n.v.*); top of Boulder Hill, 2 May 1992, *G. Wardell-Johnson* 105; West Cape Howe, Shelly Beach Rd at Lake William turnoff, 22 Feb. 1994, *J.R. Wheeler & N.G. Marchant* JRW3891.

Distribution. South West Botanical Province, IBRA regions of Warren, Jarrah Forest. Occurs in near-coastal areas from West Cape Howe to Cheyne Beach and also Mt Willyung and the Porongurup Range. (Figure 4A)

Habitat. Occurs in heath, shrubland or woodland, on sandy or loamy soils often overlying granitic rocks, only occasionally in winter-wet swamps.

Phenology. Flowers January to July, the dried petals persisting; fruits September to December but persisting until the next season or occasionally longer.

Conservation status. Often recorded as common or abundant and occurring in several national parks.

Typification. Of the four type specimens seen, the LD specimen is chosen as the lectotype as it matches the protologue and is the one most likely to have been seen by Schauer.

Notes. A variable species with several apparently disjunct populations. The populations from West Cape Howe and Peak Head are almost glabrous, with larger bracts, larger more prominently long-acuminate bracteoles and longer more narrowly acute sepals up to 2 mm long. The specimens from other populations are more variable, usually with slightly shorter sepals up to 1.5 mm long that may be glabrous or with sparse to moderately dense appressed hairs and usually with less prominently acuminate and hairier bracteoles. Some specimens from Mt Willyung, the Porongurups and the Two Peoples Bay area have narrower and more laterally curved bracteoles only 0.9–1.2 mm wide and also have subacute and often hairy sepals. The extensive variation found within populations prohibits the discrimination of intraspecific taxa based on morphology alone.

Affinities. Most similar to *T. juniperina* with which it shares the acute sepals and fairly broad bracteoles, but differs in habit, habitat, leaf shape and length (leaves shorter and almost flat in *T. juniperina*). Many specimens are superficially very similar to *T. callistachys*, differing in sepal size and shape (slightly smaller, more obtuse and usually more densely hairy in *T. callistachys*), bracteole size and shape (shorter, narrower and more distinctly laterally curved in *T. callistachys*) and also slightly in leaf shape. Both species have narrow leaves and are tapered to a similarly acute apex, but the widest part of the leaf in *T. callistachys* is above the middle so that it is extremely narrowly obovate.

Hybrids. Possible hybrids with *T. parviceps* have been noted from West Cape Howe and Betty's Beach (*J.R. Wheeler* 4049, 4050, 4051, 4055) and at Mt Mason (*E.J. Croxford* 987). Possible hybrids with *T. linearifolia* have been seen from the Porongurups (*I. Abbott s.n.*). Possible hybrids with *T. conspicua* subsp. *conspicua* have been recorded from Mt Willyung (*D. Davidson s.n.* and *J.R. Wheeler & N.G. Marchant* JRW 3904), with somewhat broader leaves to 2 mm wide. Possible hybrids with *T. marginata* have been recorded from Mt Manypeaks (*S. Barrett* 126G, *D. Davidson s.n.*).

Taxandria callistachys J.R. Wheeler & N.G. Marchant, *sp. nov.*

Species in forma folii *T. angustifoliae* similis sed bracteolis erio-pilosis, sepalis multo pilosis, plerumque florum fasciculis grandioribus et fructibus multi persistens differt.

Typus: Growing naturally on the edge of Helms Arboretum, Norseman Rd, north of Esperance, 33° 43' S, 121° 50' E, Western Australia, 4 September 2000, *J.R. Wheeler* 4057 (*holo:* PERTH 06458076; *iso*: AD, CANB, K, MEL, NSW).

Shrub erect to 2.5 m high; branchlets usually glabrous, rarely with tiny appressed hairs. *Leaves* single or occasionally clustered on short axillary shoots, usually spreading, sessile to subsessile, linear to very narrowly obovate-elliptic, distinctly concave above and convex below, 10–25 mm long, 0.8–1.8(–2.2) mm wide, glabrous or minutely hairy towards base of upper surface and usually with fine appressed marginal hairs, midrib only evident on lower surface, base gradually tapered, apex acute and shortly mucronate. *Flower clusters* usually axillary or sometimes terminating short axillary shoots, globular, 7–10 mm across, sterile basal bracts few. *Bract* broadly ovate and somewhat hooded, 1.5–2 mm long, verrucose, usually shortly woolly with short curved hairs particularly in distal half but sometimes glabrous apart from the ciliolate margin, apex obtuse. *Bracteoles* narrowly oblong to narrowly elliptic, distinctly laterally curved, 1–2 mm long, 0.4–0.5 mm wide, woolly in the distal half and on the keel, apex subacute to obtuse. *Flowers* white-petalled, 5–7 mm across. *Floral tube* 1.5–2 mm long, puberulous particularly in the distal half, scarcely extended for up to 0.2 mm above the ovary. *Sepals* triangular, (0.7–)1–1.2 mm long, usually sparsely hairy to hairy but sometimes glabrous apart from occasional apical hairs or ciliolate margin, apex subacute to obtuse. *Petals* (1.5–)2–2.5(–3) mm long including a distinct claw *c.* 0.5 mm long. *Stamens*: filament subulate to triangular, *c.* 0.5 mm long; anther ellipsoid, 0.2–0.3 mm long. *Ovary* summit glabrous; ovules 2 per cell. *Style* 1–1.5 mm long. *Infructescence* globular and 6–8 mm across to ellipsoid and 8–12 mm long. *Capsule* very broadly ovoid, 2–2.5 mm across, puberulous but often glabrescent. (Figure 3F–J)

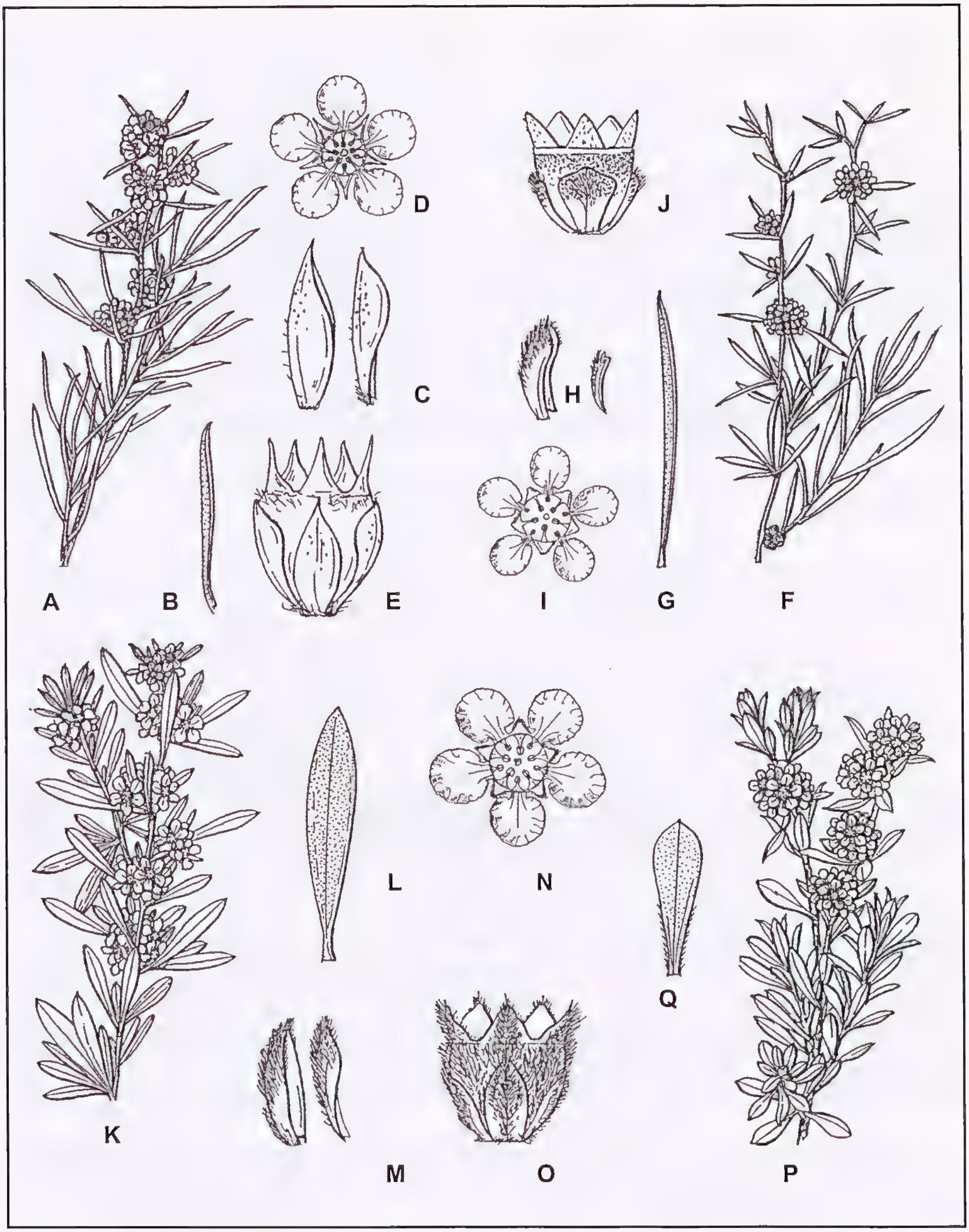

Figure 3. A–E. *Taxandria angustifolia*. A – flowering branch (×0.75), B – leaf (×1.5), C – bract and bracteole (×9), D – flower (×3), E – flower with petals removed (×6); F–J. *Taxandria callistachys*. F– flowering branch (×0.75), G – leaf (×1.5), H – bract and bracteole (×9), I – flower (×3), J – flower with petals removed (×6); K–O. *Taxandria conspicua* subsp. *conspicua*. K – flowering branch (×0.75), L – leaf (×1.5), M – bract and bracteole (×9); P, Q. *Taxandria conspicua* subsp. *abrupta*. P – flowering branch (×0.75), Q – leaf (×1.5).

Selected specimens examined. WESTERN AUSTRALIA (all PERTH except where indicated): Lucky Bay, E of Esperance, 10 Sep. 1966, *E.M. Bennett* 892A; *c.* 100 metres N of NE corner of Thistle Cove Beach, Cape Le Grand National Park, 19 Oct. 1989, *B.J. Conn & J.A. Scott* BJC3441 (AD, MEL, MO, NSW all *n.v.*); 7 km NE of Le Grand Beach on the Cape Le Grand Rd, Cape Le Grand National Park, 27 Nov. 1985, *D.B. Foreman* 1293 (AD, CANB, MEL, NSW all *n.v.*); Old Gabotich Ruins, Cape Arid, 30 Oct. 1990, *G.J. Keighery* 11707; Duke of Orleans Bay, N of Caravan Park, 62 km due E of Esperance, 28 Apr. 1980, *N.G. Marchant* 80/53 (NSW *n.v.*); Ravensthorpe, June 1924, *Ralph & Stamford s.n.*; Coramup Hill area, *c.* 30 km NE of Esperance (via Condingup Rd, Myrup Rd and Coramup Rd), 7 Nov. 1983, *P.S. Short & L. Haegi* PSS2338 (AD, MEL all *n.v.*); Cape Le Grand National Park, 1 km NE of Le Grand Beach, 6 Nov. 1982, *A. Strid* 21201; Frenchman Peak, Cape Le Grand National Park, 11 Sep. 2000, *J.E. Wajon* 186; Junction of Cape Le Grand Rd and Merrivale Rd, E of Esperance, 4 Sep. 2000, *J.R. Wheeler* 4060 (CANB, K).

Distribution. South West Botanical Province, IBRA region of Esperance Plains. Occurs from Esperance to Cape Paisley, with a western outlier recorded from Ravensthorpe. (Figure 4A)

Habitat. Occurs in heath or shrubland, usually associated with swamps or winter-wet areas near granitic outcrops.

Phenology. Flowers mostly March to September, the petals persisting for several months; fruits mostly September to January but often persisting for 2 or 3 years.

Conservation status. Widespread and quite common on the south coast.

Etymology. Derived from Greek, – *calli* beautiful and – *stachys* spike, with beautiful spikes.

Affinities. Appears to be most similar to *T. linearifolia* from which it differs in its leaf shape and sepal shape and size. *Taxandria linearifolia* has flat, often broader and widely spreading leaves, small flowers, smaller petals, sepals that are more obtuse and often slightly shorter.

Superficially similar to *Taxandria angustifolia.* The leaves of *T. callistachys* although similarly channelled above are somewhat narrowly obovate-elliptic, usually widest in the distal half, whereas those of *T. angustifolia* are more linear to very narrowly elliptic and widest at about the middle.

T. callistachys also differs in its smaller, much narrower and distinctly laterally curved bracteoles that are not or scarcely widened towards the apex and which are quite prominently woolly-hairy in the distal half. *T. angustifolia* has bracteoles that are broader, more obovate and less conspicuously hairy.

Hybrids. Possible hybrids with *T. marginata* occur over coastal granitic rocks near Esperance (*C.D. Turley* 2/793) and Cape Le Grand National Park at Frenchman's Peak (*A.S. Weston* 8968) and Thistle Cove (*C. Turley s.n.*).

Note. Some specimens from Lucky Bay to Thistle Cove have been recorded with flatter and somewhat broader leaves to 2.5 mm wide, bracts almost glabrous apart from the ciliolate margin and almost glabrous sepals.

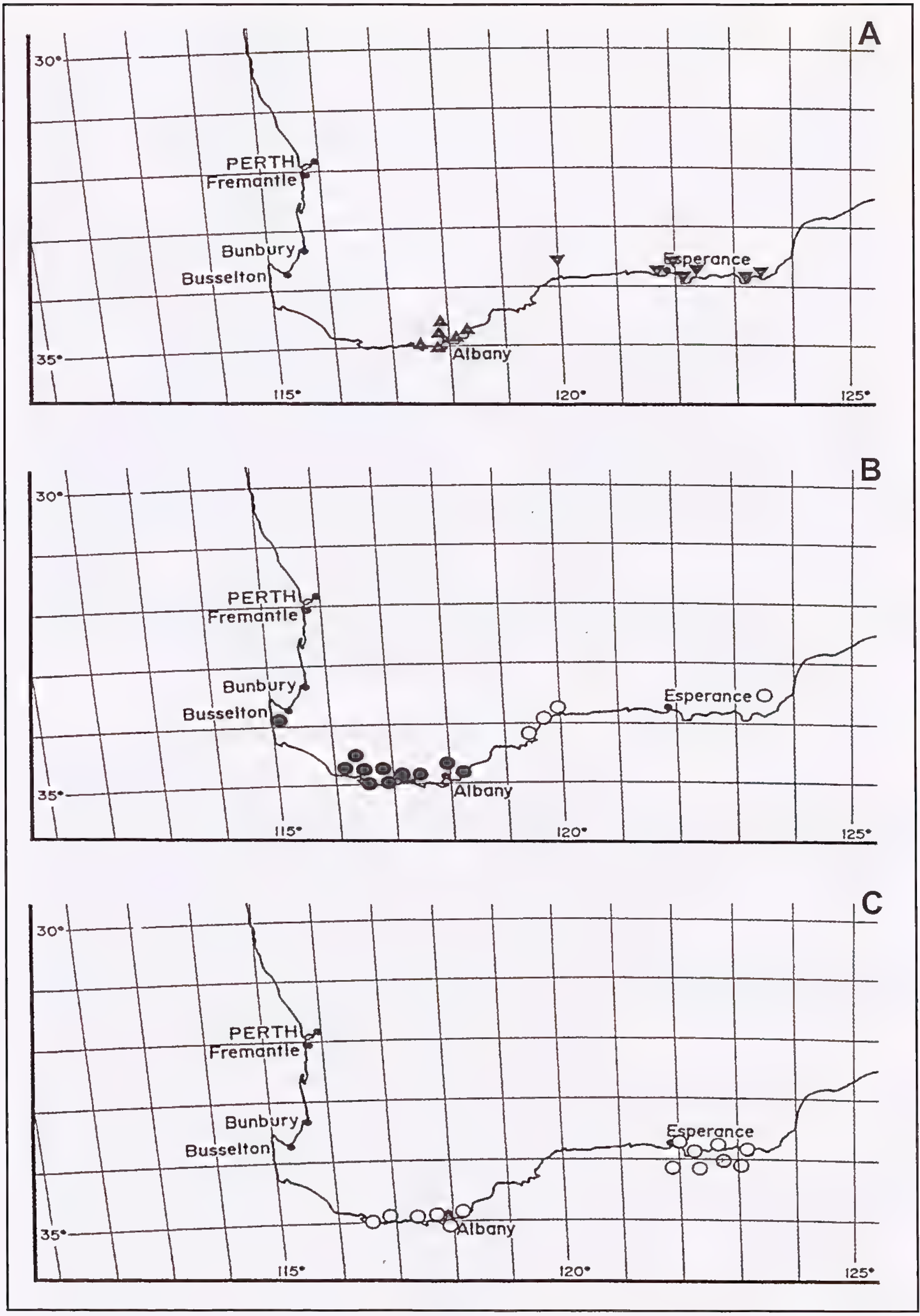

Figure 4. Distribution of *Taxandria* species. A – *T. angustifolia* ▲ and *T. callistachys* ▼; B – *T. conspicua* subsp. *conspicua* ● and *T. conspicua* subsp. *abrupta* ○; C – *T. marginata*.

Taxandria conspicua (Schauer) J.R. Wheeler & N.G. Marchant, *comb. nov.*

Agonis conspicua Schauer in Lehm., Pl. Preiss. 1: 118 (1844). – *Agonis linearifolia* var. *conspicua* (Schauer) Domin, *Vestn. Krasl. Ceske Spolecn. Nauk. Tr. Mat.- Prir.* (*Mem. Soc. Roy. Sci. Boheme Prague*) 2: 85 (1923). *Type:* "In rupestribus summitalis montis Wuljenup (Plantagenet)", [Mt Willyung, Western Australia], 13 December 1840, *Preiss* 150 *ex parte* (*lecto*: LD, here designated; *isolecto:* KW, MEL 3374 & 3378, MO).

Shrub usually to 2.5 m high, erect; branchlets sericeous to puberulous, sometimes glabrescent or glabrous. *Leaves* usually single, subsessile or with a poorly defined petiole up to 3 mm long; blade very narrowly to narrowly elliptic or obovate-elliptic or elliptic to obovate, 7–25 mm long, 2–5(–6) mm wide, very slightly to slightly concave above and convex below, gradually to abruptly tapered towards the tip and towards the base, quite thick especially towards the tip, longitudinal veins rarely evident apart from the midrib, apex acute and shortly but bluntly mucronate, glabrous or with sparse appressed hairs towards base of upper surface, sparse appressed marginal hairs apparent in at least the young leaves. *Flower clusters* axillary or terminating short axillary shoots, 7–10 mm across, sterile basal bracts few. *Bract* oblong and concavo-convex, 1.5–2 mm long, shortly and often densely hairy, apex obtuse. *Bracteoles* narrowly oblong to oblong, slightly to distinctly laterally curved, 1–2 mm long and 0.5–1 mm wide, hairy on keel and in distal half, apex obtuse. *Flowers* white-petalled, 4–9 mm across. *Floral tube* 1.5–2 mm long, sericeous, extending for 0.5–0.8 mm above the ovary. *Sepals* ovate-triangular, 0.8–1.2 mm long, sericeous or with spreading hairs, apex more or less obtuse. *Petals* 1.5–3 mm long including a distinct claw *c.* 0.5 mm long. *Stamens*: filament 0.3–0.8 mm long; anther 0.2–0.3 mm long. *Ovary* summit glabrous; ovules 2 per cell. *Style* 1–1.5 mm long. *Infructescence* globular and 6–10 mm across or ellipsoid to cylindric and 10–15 mm long and 8–10 mm wide. *Capsule* broadly cup-shaped to turbinate, 2–3 mm across, shortly hairy to glabrous.

a. Taxandria conspicua (Schauer) J.R. Wheeler & N.G. Marchant **subsp. conspicua**

Shrub to 1.5 m high; branchlets usually glabrous or glabrescent. *Leaves* subsessile, erect to slightly spreading, very narrowly to narrowly elliptic or obovate-elliptic, 10–25 mm long, 1.5–4(–6) mm wide, very slightly to slightly concave above and convex below, gradually tapered towards the tip and towards the base, quite thick especially towards the tip, apex acute and shortly but bluntly mucronate. *Flower clusters* usually axillary, *c.* 10 mm across. *Bract* broadly oblong, 1.5–2.5 mm long, concavo-convex, apex obtuse, shortly hairy. *Bracteoles* oblong and slightly laterally curved, 1.5–2 mm long, 0.5–1 mm wide, hairy particularly down the centre. *Flowers* 5–9 mm across. *Sepals* 0.7–1.3 mm long, with spreading hairs, apex obtuse. *Petals* 2–3 mm long. *Infructescence* globular and *c.* 10 mm across or ellipsoid to cylindric and 10–15 mm long and 8–10 mm wide. (Figure 3K–O)

Selected specimens examined. WESTERN AUSTRALIA (all PERTH except where indicated): Devils Slide Porongurup Range, 25 Apr. 1952, *W.A. Atkins* 98; Walpole, Frankland State Forest, 8 Oct. 1989, *B.J. Conn & J.A. Scott* BJC3350 (MO *vide*, MEL, NSW both *n.v.*); 1.5 km NW of Shannon on the Manjimup - 1.4 km on Chesapeake Rd from Junction with Springbreak Rd, 25 Feb. 1997, *C. Godden & N. Casson* W132.1; Denmark Shire, Mt Lindesay walk track, just above first large granite, *c.* 2.5 km E from Denmark River, 14 Apr. 1992, *B.G. Hammersley* 577; Lookout Rocks, 2 km SSE of Mt Chudalup, *c.* 4 km N of Windy Harbour, 19 Feb. 1982, *G.J. Keighery* 4490; Last Bottle Rock, W of Shannon River townsite, South West Highway, 6 July 1979, *N.G. Marchant* 79/59; Muirillup Rock, SE of Northcliffe, 6 July 1979, *N.G. Marchant* 79/62; *c.* 17 metres below summit on NE face of Mt Frankland, 29 km (by road) N of Yelverton FR 0883, 10 Dec. 1986, *G.S. McCutcheon* 1485A; Walpole Rd, 14 Aug. 1979, *J.M. Powell* 1162 (CANB, K, L, MEL, NSW all *n.v.*); Walpole–Nornalup National Park, Nuyts Wilderness, Mt Hopkins, 22 Sep. 1992, *J.R. Wheeler* 3249.

Distribution. South West Botanical Province, IBRA regions of Warren and Jarrah Forest. Scattered from south of Pemberton to Walpole and east to the Porongurups and Mt Willyung, with an isolated record from Yelverton near Busselton. (Figure 4B)

Habitat. Apparently restricted to winter-wet areas of granitic outcrops.

Phenology. Flowering irregular, recorded for February to April and also July to September; fruits persisting for at least one year.

Conservation status. Quite common on granitic outcrops near the south coast.

Typification. Of the five type specimens seen, the LD specimen is chosen as the lectotype as it matches the protologue and is the one most likely to have been seen by Schauer.

Affinities. Differs from *T. conspicua* subsp. *abrupta* in leaf shape, with its leaves usually longer, usually more elliptic in shape and more gradually tapered at each end. Subsp. *conspicua* also differs from subsp. *abrupta* in its slightly larger flower clusters. The flowers of subsp. *conspicua* have slightly larger petals, slightly broader and less conspicuously laterally curved bracteoles and often slightly larger sepals. The infructescences of subsp. *conspicua* are also often larger.

Taxandria conspicua subsp. *conspicua* differs from *T. marginata* in its leaves that have less obvious more appressed marginal hairs and lack obvious longitudinal veins apart from the midrib. *Taxandria marginata* occurs in similar granitic areas to *T. conspicua* subsp. *conspicua*, but is usually closer to the coast. *Taxandria linearifolia* differs in its flatter, more spreading leaves and smaller flowers.

Notes. Taxandria conspicua subsp. *conspicua* was previously known by the informal name '*Agonis* sp. Last Bottle Rock'.

As well as the differences of leaf shape and flowers, the two subspecies of *T. conspicua* also differ in habitat, subsp. *conspicua* being apparently restricted to winter-wet areas of granite whereas subsp. *abrupta* occurs on a variety of soil types in heath or shrubland. There is apparently no overlap in distribution of the two subspecies.

Hybrids. Possibly hybridising with *T. linearifolia* at Last Bottle Rock (west of Shannon) and Muirillup Rock, with *T. angustifolia* at Mt Willyung (*D. Davidson s.n.* and *J.R. Wheeler & N.G. Marchant* JRW 3904) and with *T. parviceps* at Mt Chudalup (*R.J. Cranfield* 10330) and elsewhere where both taxa occur and plants intermediate in various characters may be found.

b. **Taxandria conspicua** subsp. **abrupta** J.R. Wheeler & N.G. Marchant, *subsp. nov.*

Taxandriae conspicuae subsp. conspicuae affinis sed foliis brevioribus et in quoque extremo abrupte angustis, fasciculis florum minoribus et petalis minoribus differt.

Typus: SE side of East Mount Barren above first car park, W of ranger's residence 33° 55' 06" S 120° 00' 48" E [Western Australia] Shrub to 1.5 m. On rocky clay flat. Growing with *Agonis obtusissima*, 3 December 1979, *N.G. Marchant* 79/86 (*holo*: PERTH 4034694).

Agonis spathulata var. *angustifolia* Benth., Fl. Austral. 3, 97 (1867). *Type*: East Mount Barren, [Western Australia], *Maxwell* (*holo*: *n.v.*; *iso*: ?MEL 977).

Shrub to 2.5 m high; branchlets sericeous and glabrescent to glabrous. *Leaves* with a somewhat poorly defined petiole, erect to slightly spreading, usually obovate to obovate-elliptic and sometimes somewhat narrowly so, 6–15(–25) mm long and (2–) 2.5–5 mm wide, slightly concave above and convex below, usually abruptly tapered towards the tip and base, apex abruptly acuminate and shortly but bluntly mucronate. *Flower clusters* axillary or terminal, 7–10 mm across. *Bract* usually oblong to broadly oblong, rarely ovate, 1.5–2 mm long, concavo-convex, apex obtuse, shortly and densely hairy. *Bracteoles* narrowly oblong and distinctly laterally curved, 1–1.5 mm long and *c.* 0.5 mm wide, densely hairy. *Flowers* 4–7 mm across. *Sepals* 0.8–1 mm long, densely sericeous, apex obtuse. *Petals* 1.5–2.5 mm long. *Infructescence* globular and 7–10 mm across, the shoot often growing out. (Figure 3P,Q)

Selected specimens examined. WESTERN AUSTRALIA (all PERTH except where indicated): Mt Ragged, 26 Sep. 1995, *S. Barrett* 490; Mt Ragged Range, 2.5 km S of Tower Peak, 6 Jan. 1979, *M.D. Crisp* 4813 (CBG, NSW all *n.v.*); 5 km WNW West Mt Barren, 12 Mar. 1996, *R. Davis* 520; Fitzgerald River National Park, summit area of Mt Drummond, 31 Jan. 1986, *J.M. Fox* 86/127 (CANB *n.v.*) West Mt Barren, 29 Nov. 1960, *A.S. George* 1803; on slopes of Whoogarup Range, 2 Dec. 1960, *A.S. George* 1953; On southern face of East Mt Barren, 1 Dec. 1970, *B.R. Maslin* 951; Mt Maxwell, car park to the summit track, 16 Sep. 1992, *C.J. Robinson* 934; Thumb Peak, Fitzgerald River National Park, 23 Oct. 1970, *R.D. Royce* 9267.

Distribution. South West Botanical Province, IBRA region of Esperance Plains. A disjunct distribution, being recorded from Fitzgerald River National Park and Mt Ragged. (Figure 4B)

Habitat. Occurs in heath or shrubland, on sandy, loamy or rocky soil. Often found with *T. spathulata.*

Flowering period. Flowers recorded July to September but also March to April; fruits persist for at least one year.

Conservation status. Relatively widespread and occurs in two large national parks.

Etymology. Derived from Latin *abruptus* (abruptly) referring to the more abruptly tapered leaf apex and base of most of the specimens of this subspecies. The varietal epithet *angustifolia* was not used because the leaves of this variety are wider than the typical variety and this name could be confused with the epithet of another species of *Taxandria.*

Affinities. Differs from *T. conspicua* subsp. *conspicua* in leaf shape, in having usually shorter leaves, usually more distinctly obovate and more abruptly tapered at each end. Subsp. *abrupta* also differs from subsp. *conspicua* in its slightly smaller flower clusters. The flowers of subsp. *abrupta* have slightly smaller petals, slightly narrower and more conspicuously laterally curved bracteoles and slightly smaller sepals. The infructescences of subsp. *abrupta* are also usually somewhat smaller. Differs from *T. linearifolia* in habitat (*T. linearifolia* grows along watercourses) and also in leaf shape.

Hybrids. No hybrids have been recorded involving *Taxandria conspicua* subsp. *abrupta.*

Notes. This subspecies varies in habit from a wind-pruned shrub less than 0.5 m high to a more robust shrub to 2.5 m high in gullies or areas receiving roadside drainage run-off. These latter plants (e.g.

J.R. Wheeler 4104) approach *T. conspicua* subsp. *conspicua*. There is considerable variation in leaf size and flower cluster size from plants in differing habitats. Some collections from West Mt Barren (*C.J. Robinson* 916) and Cape Arid (*R.D. Royce* 9897) have leaves that are unusually long, slender and subsessile, but other specimens from West Mt Barren (*J.R. Wheeler* 4082) have more the usual, shorter obovate-elliptic leaves.

Taxandria floribunda (Turcz.) J.R. Wheeler & N.G. Marchant, *comb. nov.*

Agonis floribunda Turcz., *Bull. Soc. Nat. Mosc.* 22(2): 20 (1849). *Type*: [Western Australia], *Drummond* IV n. 56 (*holo:* KW; *iso:* K, MEL 987, NY, P).

Shrub to 2 m high, erect, usually single-stemmed; main stems and branches thickened towards the base; branchlets softly hairy with long spreading hairs but glabrescent. *Leaves* single, sometimes crowded but not clustered except around flower heads, subsessile or with petiole up to 2 mm long; blade obovate or obovate-elliptic, sometimes narrowly so, often undulate or twisted and often recurved towards the apex, (3.5–)5–15(–18) mm long and 1.5–4.5(–7) mm wide, with 1 or 3 longitudinal veins, softly hairy when young but glabrescent, tapered to the base, margin usually minutely and irregularly indented, apex obtusely acuminate and mucronate. *Flower clusters* axillary or terminating short shoots, 5–10 mm across, often few-flowered, surrounded by a conspicuous and persistent involucre of sterile bracts. *Bracts*: outer sterile bracts numerous, broadly ovate, 1.5–2 mm long, the inner fertile bracts ovate-elliptic to elliptic and 3.5–5 mm long and 3–3.5 mm wide, apex obtuse or obtusely acuminate, usually with soft hairs towards the apex. *Bracteoles* linear to very narrowly elliptic, not or scarcely laterally curved, 3–4 mm long and 0.2–0.5 mm wide, with dense spreading white hairs particularly towards the apex and down the centre. *Flowers* white or pale pink-petalled, 3–6 mm across. *Floral tube* obconic to cylindric, 2–3 mm long, usually softly hairy, clearly extended above the ovary surface for *c.* 1 mm. *Sepals* ovate-triangular, 1.5–2 mm long, densely white-sericeous, the hairs exceeding the more or less acute apex. *Petals* obovate-spathulate, 2–3.5 mm long including a distinct claw 1–1.5 mm long. *Stamens*: antisepalous stamens nodding and with a slender filament *c.* 0.5 mm long; antipetalous stamens erect with a thickened filament 1–1.5 mm long and fused to the base of the petal; anther 0.2-0.3 mm long. *Ovary* summit glabrous or with a few hairs; ovules 2 per cell. *Style* 2–3 mm long, capitate. *Infructescence* small surrounded by the persistent involucre of bracts. *Capsule* cylindric, 2–3 mm long, 2–2.5 mm wide, sericeous but sometimes glabrescent. (Figure 5A–E)

Selected specimens examined. WESTERN AUSTRALIA (all PERTH except where indicated): Mondurup (218), Stirling Range, Albany East, 31 Oct. 1994, *S. Barrett* 257; Hume Peak, Stirling Range, 8 May 1995, *S. Barrett* 327.8; West Cranbrook, 16 Oct. 1966, *H.E. Daniels s.n.*; Stirling Range National Park, on hill 5.5 km due W of junction of Stirling Range Drive and Red Gum Pass Rd, 9 Oct. 1988, *J.M. Fox* 88/278 (CANB, MEL both *n.v.*); Stirling Range National Park, Stirling Range Drive, 37 km from Chester Pass Rd, lookout SW of Baby Barnett Hill, 23 Oct. 1991, *W. Greuter* 23168; base of Peak Donnelly, Stirling Ranges, 7 Nov. 1977, *G.J. Keighery* 1254; between Quarry Track and West Track, far SW corner of Stirling Range National Park, 5 Dec. 1979, *N.G. Marchant* 79/101; Mt Trio, 26 Oct. 1985, *E. & S. Pignatti* 1596; Red Gum Springs, Stirling Range, Oct. 1963, *W. Rogerson* 49; Base of Bluff Knoll, south face, Stirling Range National Park, 27 Oct. 1959, *R.D. Royce* 6050.

Distribution. South West Botanical Province, junction of IBRA regions of Jarrah Forest, Avon Wheatbelt and Esperance Plains. Apparently restricted to the Stirling Range National Park and near Cranbrook. (Figure 6A)

Habitat. Occurs in heath or mallee-heath on lower and upper slopes of mountain peaks, on sand or sandy clay over quartzite or on stony ground, occasionally on peaty sand associated with swamps or winter-wet depressions.

Phenology. Flowers recorded mostly October but extending to December. Fruits persist for several years.

Conservation status. Restricted in distribution, but quite widely scattered through a large national park.

Notes and affinities. *Taxandria floribunda* is unusual in this genus in a number of features, the most striking of which is the presence of a persistent involucre of numerous sterile bracts that closely surround the inflorescence concealing the fruits. The flowering shoots continue to grow after fruiting resulting in branches having several successive years' fruits (still surrounded by their involucres). The flowers are commonly pale pink rather than white-petalled. The bracteoles are unusually long (3.5–4 mm) and slender. The antipetaline staminal filaments are almost twice the length of the antisepaline filaments and appear to be fused to the base of the petal claw.

Taxandria floribunda is distinctive in an otherwise quite cohesive and uniform genus. However with available morphological evidence it is considered that the species is best placed in *Taxandria*. The *species* resembles *T. spathulata*. Both taxa have a distinct extension of the floral tube beyond the ovary of *c.* 1 mm, a little longer than in other species of *Taxandria*. Both have particularly long petal claws (up to 1.5 mm long in *T. floribunda* and 1 mm long in *T. spathulata)* and both also have somewhat narrower capsules than is usual for the genus.

Hybrids. No hybrids involving *T. floribunda* have been recorded.

Taxandria fragrans (J.R. Wheeler & N.G. Marchant) J.R. Wheeler & N.G. Marchant, *comb. nov.*

Agonis fragrans J.R. Wheeler & N.G. Marchant, *Nuytsia* 13(3): 567–570 (2001). *Type*: Marbellup Rd North, 6.2 km north of South Coast Highway, Western Australia, 26 July 2000, *J.R. Wheeler* 4044 (*holo*: PERTH 06315305; *iso*: AD, CANB, K, MEL).

Illustration: Wheeler *et al.* (2001: Figure 1).

Shrub up to 2.4 m high with rigid foliage and large clusters of flowers. *Flowers* characterised by their broad bracts, broad obtuse to emarginate bracteoles and glabrous acute sepals. For a complete description see Wheeler *et al.* (2001).

Selected specimens: see Wheeler *et al.* (2001).

Distribution. South West Botanical Province, IBRA regions of Warren and Jarrah Forest. Occurs from near Margaret River to east of Denmark near Redmond and Marbellup, with a single record from between Williams and Kojonup. (Figure 6B)

Habitat. Occurs in swamps on acid peaty sand and in the seasonally waterlogged margins of broad upper valleys, often in association with *Beaufortia sparsa* and *Homalospermum firmum*. *Taxandria fragrans* often occurs near *T. parviceps* (but usually at lower elevations) and the latter species is found in a greater variety of habitats. Also occasionally found growing near *T. juniperina*.

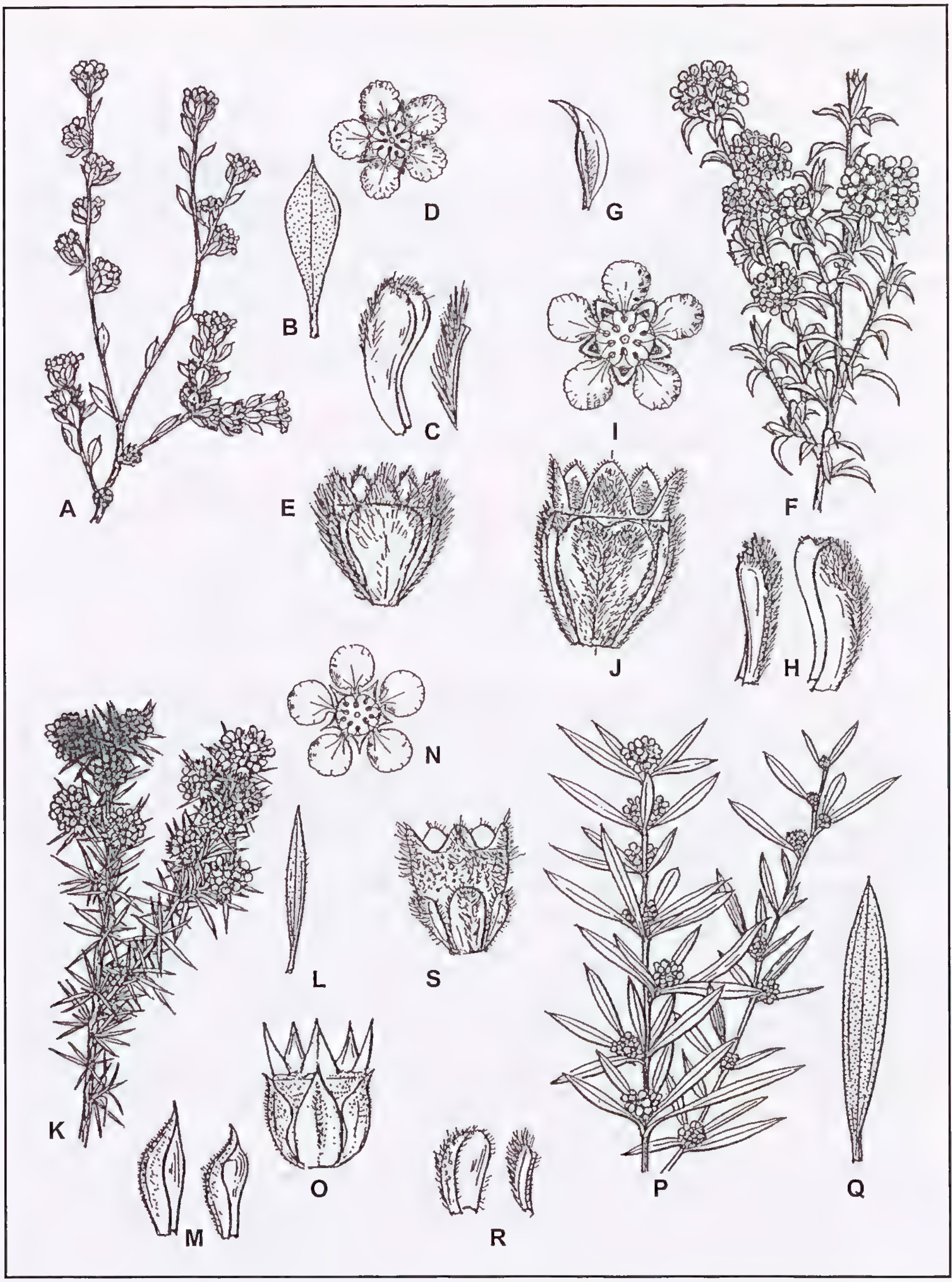

Figure 5. A–E. *Taxandria floribunda*. A – flowering branch (×0.75), B – leaf (×1.5), C – bract and bracteole (×9), D – flower (×3), E – flower with petals removed (×6); . F–J. *Taxandria inundata*. F – flowering branch (×0.75), G – leaf (×1.5), H – bract and bracteole (×9), I – flower (×3), J – flower with petals removed (×6); K–O. *Taxandria juniperina*. K– flowering branch (×0.75), L – leaf (×1.5), M – bract and bracteole (×9), N – flower (×3), O – flower with petals removed (×6); P–S. *Taxandria linearifolia*. P – flowering branch (×0.75), Q – leaf (×1.5), R – bract and bracteole (×9), S – flower with petals removed (×6).

Phenology. Flowers mostly February to May but petals persist until at least fruit matures; fruits May to November, usually persisting until the following season or longer.

Conservation status. Recorded from a number of localities over a wide area.

Affinities. Similar to *T. juniperina* and *T. parviceps*, from which it differs in its habit and flowering time as well as in its foliage and flowers. *Taxandria juniperina* has softer foliage, smaller flower clusters with slightly smaller bracts, bracteoles, sepals and petals. *Taxandria parviceps* has shorter somewhat recurved leaves, smaller flower clusters and flowers that have smaller emarginate bracts and bracteoles, smaller obtuse and somewhat hairy sepals and smaller petals.

Hybrids. Possible hybrids have been recorded between *T. fragrans* and *T. parviceps* near Margaret River (*R. Smith* 010) and near Walpole (*Gibson & Lyons* 449).

Taxandria inundata J.R. Wheeler & N.G. Marchant, *sp. nov.*

In forma foliorum, bractearum et bracteolearum *T. parvicipi* similis sed inomnino aspectibus grandioribus, multo dense pilosis et foliis 3–5-nervosis differt.

Typus: near Molloy Island, Augusta, Fisher Rd, 7.4 km from Kudardup, 34° 16' S, 115° 12' E, Western Australia, 6 September 1991, *J.R. Wheeler* 2652 (*holo*: PERTH 04418468; *iso*: K, MEL).

Shrub 0.5–2 m high, often with rather blackish stems; branchlets with dense appressed to erect white hairs. *Leaves* commonly in clusters but occasionally single, subsessile, spreading to recurved: blade obovate to elliptic, often broadly so or less often narrowly so, somewhat recurved towards apex, 6–14 mm long, (2–)3–6 mm wide, sparsely to densely hairy, with 3–5 longitudinal veins, apex acutely to obtusely mucronulate. *Flower clusters* terminating short stout axillary shoots, 8–15 mm across, very densely sericeous in bud, several-flowered, sterile basal bracts few. *Bract* broadly obovate or circular to depressed obovate, (2.2–)3–3.5 mm long, (2.5–)3–4 mm wide, densely sericeous, apex obtuse to emarginate. *Bracteoles* broadly obovate to very broadly obovate, slightly laterally curved, (2.2–)3–3.5 mm long, 2–3 mm wide, densely sericeous particularly on keel, the margins somewhat thinner and almost glabrous, apex obtuse or emarginate. *Flowers* 5–8 mm across. *Floral tube* cup-shaped, 2–2.5 mm long, usually densely hairy, slightly extended for up to 0.5 mm above the ovary. *Sepals* ovate-triangular, 1–1.7 mm long, densely hairy except in the membranous and almost glabrous distal third, apex obtuse to subacute. *Petals* 2.5–3.5 mm long including a distinct claw 0.2–1 mm long. *Stamens*: filament *c.* 0.5 mm long; anther 0.3–0.5 mm long. *Ovary* summit glabrous; ovules 2 per cell. *Style* 1–2 mm long. *Infructescence* globular to ovoid, 7–12 mm across. *Capsule* broadly cup-shaped to turbinate, 2.2–3 mm across, shortly hairy. (Figure 5F–J)

Selected specimens examined. WESTERN AUSTRALIA (all PERTH except where indicated): *c.* 6 km N of Windy Harbour on road to Northcliffe, 1 Mar. 1995, *A.R. Annels* 5335; Boggy Lake, Walpole, Mar. 1957, *D.M. Churchill s.n.*; Weld River swamp, 4.5 miles [7.2 km] S of Shannons Mill, Mar. 1957, *D.M. Churchill s.n.*; Scott River Rd, Augusta, 23 Apr. 1981, *E.J. Croxford* 1481; 6 miles [9.6 km] S of Northcliffe, 10 Mar. 1967, *A.S. George* 8668; Denmark Shire, Boat Harbour, swamp on N side of 4WD track, 13 Oct. 1991, *B.G. Hammersley* 567; Scott River Rd just E of Johnson Rd, Scott National Park, *c.* 10 km E of Augusta, 28 Jan. 1988, *G.J. Keighery* 9614 (CANB *n.v.*); Lake Quitjup, 23 Apr. 1991, *C.J. Robinson* 562; E of Nillup on Brockman Highway, 21 Feb. 1973, *R.D. Royce* 10499; Lake Jasper, May 1967, *J.G.E. Schoneveld* 118.

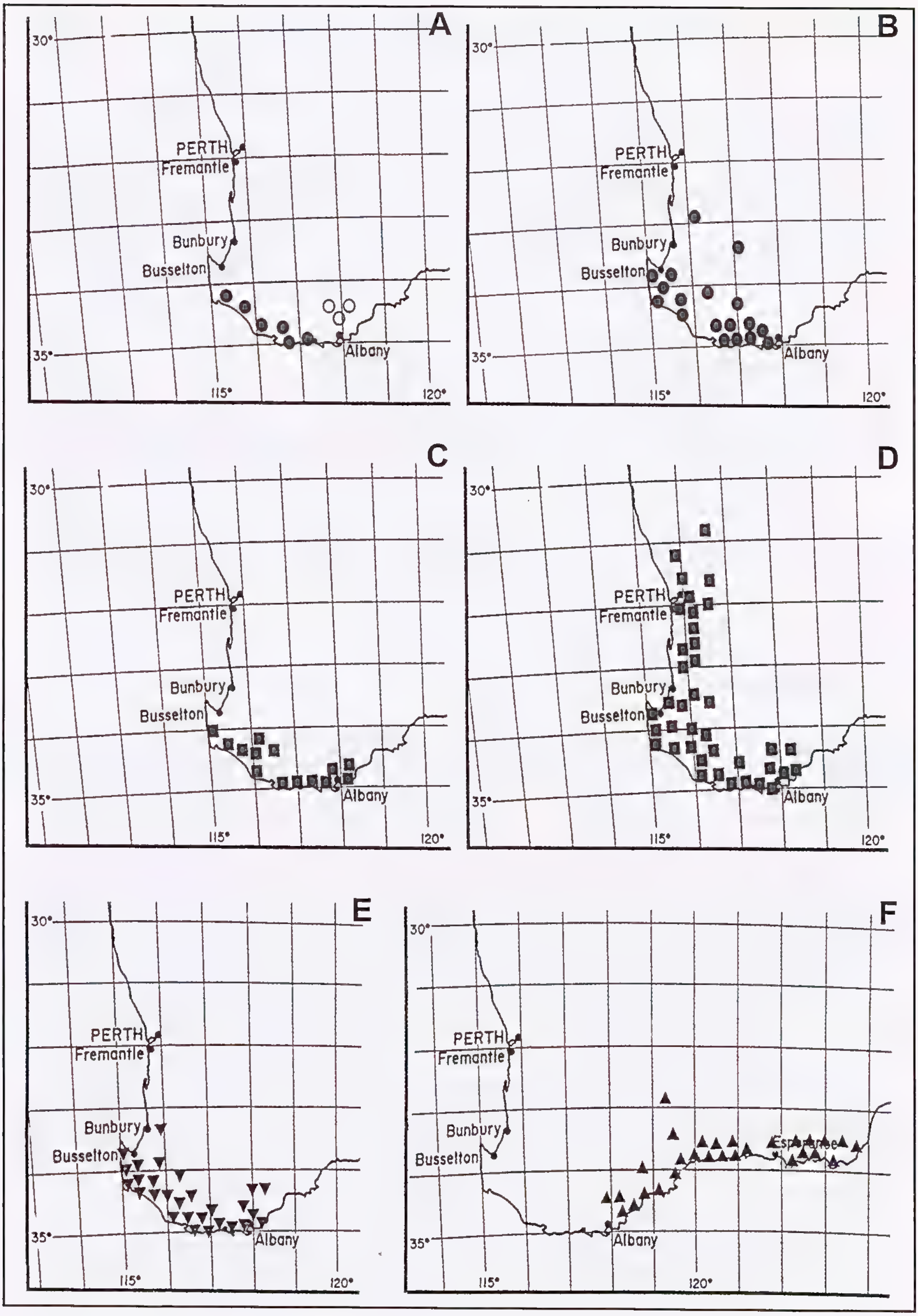

Figure 6. Distribution of *Taxandria* species. A – *T. floribunda* ○ and *T. inundata* ●; B – *T. fragrans*; C – *T. juniperina*. D – *T. linearifolia*; E – *T. parviceps*; F – *T. spathulata*.

Distribution. South West Botanical Province, IBRA region of Warren. Occurs from Augusta eastwards to Boat Harbour, west of Denmark. (Figure 6A)

Habitat. Occurs on lake margins or in seasonally to permanently waterlogged depressions in sedgeland or shrubland on sandy or clay soils.

Phenology. Flowers mainly January to June, with petals persisting until November; fruits mainly October to December, but old fruits persisting until the following season or occasionally longer.

Conservation status. Quite widespread in moist localities, in some cases reported as common.

Etymology. Derived from Latin *inundatus* – flooded, usually applied to places covered with water during part of the year and referring to the habitat of this species.

Affinities. Taxandria inundata is similar to *T. parviceps,* both having spreading to recurved leaves and emarginate bracts and bracteoles. *T. inundata* differs from *T. parviceps* in habitat preferences, its blackened stems, larger leaves and flowers, and in its more densely hairy bracts, bracteoles and sepals.

Notes. Previously known by the informal phrase name '*Agonis* sp. Lake Jasper (*B. Hammersley* 567)'.

Hybrids. No hybrids have been recorded involving *T. inundata.*

Taxandria juniperina (Schauer) J.R. Wheeler & N.G. Marchant, *comb. nov.*

Agonis juniperina Schauer in Lehm., Pl. Preiss. 1: 118 (1844). *Type*: "In glareosis sterilibus promontorii Cape Riche", [Western Australia], 20 November 1840, *Preiss* 314 (*lecto*: LD, here designated; *isolecto*: MEL 3281).

Tree or tall shrub, erect to 27 m high; branchlets puberulous and pilose, rarely glabrous. *Leaves* usually in clusters that at length elongate into axillary shoots but occasionally single, subsessile, linear to very narrowly elliptic, flat to slightly or occasionally distinctly concave above and convex below, (4–)7–13(–15) mm long, 0.3–1.5 mm wide, glabrous apart from appressed and often sparse marginal hairs, with only the base of the midrib evident on the lower surface, base gradually tapered, apex acute and shortly mucronate. *Flower clusters* globular, terminating short axillary shoots, 6–8 mm across, sterile basal bracts few. *Bract* broadly ovate to broadly obovate, 1–2.5 mm long, 1–2(–2.5) mm wide, keeled, glandular-punctate and somewhat verrucose, glabrous or hairy particularly on the keel, apex acute to long-acuminate. *Bracteoles* broadly obovate to spathulate, 1.8–2.7 mm long, 1.2–2 mm wide, keeled, not or only very slightly laterally curved, glandular-punctate and usually somewhat verrucose, glabrous or hairy particularly on keel, apex obtuse to acute or obtusely but distinctly acuminate. *Flowers* white-petalled, 4–7 mm across. *Floral tube* 1.3–2 mm long, puberulous, slightly extended for up to 0.5 mm above the ovary. *Sepals* white, triangular, 1–2 mm long, glabrous, long-acute. *Petals* 1.5–2.5 mm long including a distinct claw 0.2–0.8 mm long. *Stamens*: filament slender, 0.5–0.8 mm long; anther *c.* 0.3 mm long. *Ovary* summit glabrous; ovules 2 per cell. *Style* 0.5–1.8 mm long. *Infructescence* globular to ellipsoid, 8–10 mm long and 8–10 mm across. *Capsule* broadly cup-shaped to broadly ovoid or somewhat 3-lobed, 2.5–3 mm across, glabrous to puberulous. (Figure 5K–O)

Selected specimens examined. WESTERN AUSTRALIA (all PERTH except where indicated): Lake Saide off Lower Denmark Rd, W of Albany, 18 June 1984, *D. Davidson s.n.*; Little Beach Walk Trail, Two Peoples Bay, 17 May 1999, *R. Davis* 8836; *J. Drummond* 4: 58 (NY as 58, P); Deep River, SW Western Australia, Dec. 1912, *S.W. Jackson s.n.*(CANB *n.v.*); Lake William, West Cape Howe, 25 km W of Albany, 27 Nov. 1986, *G.J. Keighery* 11621 (CBG *n.v.*); William Bay National Park, Jan. 1984, *C.V. Malcolm* 82 (CANB *n.v.*); South West, Plantagenet, Apr. 1901, *E. Pritzel* 324 (GH, MO, P); 0.5 km N of South West Highway, 5 km E of Kent Rd (Powell's property), 13 Nov. 1985, *A.N. Rodd & G. Fensom* ANR4945 (NSW *n.v.*); Forest Grove Rd, 5 km W of Bussell Highway, 19 Feb. 2000, *J. Scott* 195; Pemberton, *s. dat.*, *N.H. Speck s.n.*; 7 miles [11 km] W of Albany on the Elleker Road, 23 Mar. 1970, *M.D. Tindale* 335 & *B.R. Maslin* (NSW *n.v.*); Brennans Ford, bridge over Scott River, 6 Sep. 1991, *J.R. Wheeler* 2656 (MEL).

Distribution. South West Botanical Province, IBRA regions of Warren and Jarrah Forest. Occurs from Forest Grove and Scott River east to the Kalgan River and Waychinicup. See note under typification. (Figure 6C)

Habitat. Occurs on the margins of winter-wet or permanent swamps or watercourses, sometimes forming dense thickets. Colloquially known as "Wattie".

Phenology. Flowers mainly February to May, the petals persisting for several months; fruits mainly September to December and persisting until the following season or occasionally longer.

Conservation status. Widespread and common along the south-west coast and occurring in several national parks.

Typification. Of the two type specimens seen, the LD specimen is chosen as the lectotype as it matches the protologue and is the one most likely to have been seen by Schauer. The type locality of Cape Riche must be questioned as *Taxandria juniperina* is not known from that location. It may be that Preiss collected the species on the way to Cape Riche as it is known to occur nearby but closer to Albany.

Affinities. Taxandria juniperina is similar to *T. angustifolia* and *T. fragrans*, both of which have the similar acute sepals and broad bracteoles. *Taxandria fragrans* differs in habit, its larger flower clusters and the shape of the bracts (obtuse to obtusely acuminate in *T. fragrans*) and bracteoles (obtuse or emarginate in *T. fragrans*). *T. fragrans* also has much coarser more rigid foliage. *Taxandria angustifolia* differs from *T. juniperina* in habit, habitat preferences and in leaf length and shape (longer and distinctly concave above and convex below in *T. angustifolia*).

Immature trees of *Taxandria juniperina* superficially resemble *T. parviceps* and the two taxa have previously sometimes been confused. They clearly differ in leaf posture (somewhat recurved in *T. parviceps*), sepals (obtuse rather than acute in *T. parviceps*), bracts (emarginate to obtusely 2-lobed in *T. parviceps*) and bracteoles (narrower and more distinctly laterally curved as well as being obtuse to emarginate in *T. parviceps*) as well as their habitat preferences.

Hybrids. Possible hybrids have been recorded with *T. conspicua* at Shannon (*J.R. Wheeler* 2659).

Taxandria linearifolia (DC.) J.R. Wheeler & N.G. Marchant, *comb. nov.*

Leptospermum linearifolium DC., Prodr. 3: 227 (1828) – *Agonis linearifolia* (DC.) Sweet, Sweet's Hort. Brit. ed 2, 209 (1830). – *Billottia linearifolia* (DC.) R. Br., *J. Roy. Geogr. Soc.* 1: 19 (1832). – *Billotia linearifolia* (DC.)G. Don, Gen. Hist. 2, 827 (1832). *Type*: In Nova Hollandia orient ad insulam Decres, ?*Leschenault* (*holo*: G *n.v.*, photograph seen).

Illustration. N.G. Marchant *et al.* (1987), Figure 139.

Shrub or small *tree* to 5 m high, sometimes weeping; branchlets glabrous or softly pilose to puberulous. *Leaves* usually single, sometimes clustered on short axillary shoots, well-spaced and usually widely spreading to deflexed, subsessile or with an indistinct petiole up to 2 mm long; blade very narrowly elliptic to narrowly obovate-elliptic, flat or almost so, 7–45 mm long, 0.5–4 mm wide, glabrous or minutely hairy towards base of upper surface or rarely finely pilose when young, midrib and also sometimes 2 more very faint longitudinal veins evident on lower surface, base tapered, sometimes with sparse appressed marginal hairs, apex acute and shortly mucronate or less often obtuse. *Flower clusters* axillary or occasionally terminating short axillary shoots, 5–9 mm across, sterile basal bracts few. *Bract* broadly oblong to broadly ovate, 1–1.5 mm long, shortly but quite densely hairy particularly in distal half, apex obtuse. *Bracteoles* narrowly oblong to narrowly spathulate, distinctly laterally curved, 1–1.5 mm long, 0.3–0.6(–0.8) mm wide, woolly-hairy on keel and in distal half, apex obtuse. *Flowers* white-petalled, 3.5–5 mm across. *Floral tube* 1–2 mm long, hairy particularly in distal half, extended for up to 0.5 mm above the ovary. *Sepals* broadly ovate to semicircular, 0.4–0.7(–1) mm long, woolly-hairy and usually quite densely so, apex obtuse. *Petals* 1.4–2.2 mm long including a distinct claw *c.* 0.5 mm long. *Stamens*: filament 0.3–0.8 mm long; anther 0.2–0.3 mm long. *Ovary* summit glabrous; ovules 2 per cell. *Style* 1–1.5 mm long. *Infructescence* globular to ellipsoid, 6–8 mm across. *Capsule* ovoid to cylindric, *c.* 2 mm across, shortly villous but often glabrescent. (Figure 5P–S)

Selected specimens examined. WESTERN AUSTRALIA (all PERTH except where indicated): Porongurup Range, northern side, 30 Sep. 1991, *I. Abbott s.n.*; Port du Roi George, *Baudin s.n.* (P); Wongan Hills, 27 Nov. 1917, *J. Benkers s.n.*; 6 km N of Augusta near junction of Caves Rd and Green Hill Rd, 26 Oct. 1983, *M.G. Corrick* 8940 (CBG, HO, MEL all *n.v.*); *J. Drummond* 143 (P); near Denmark River on road to Mt Lindesay, *c.* 22 km N of Denmark, 4 Dec. 1985, *D.B. Foreman* 1472 (K *vide*, AD, CANB, K, MEL, NSW all *n.v.*); Preston River, Boyanup, 18 Oct. 1920, *C.A. Gardner* 437; Cookernup, 9 Apr. 1955, *J.W. Green* 326; opposite Golf Course, Rest Point, 5 km W of Rest [Point], 3 Nov. 1986, *G.J. Keighery* 8773; Stirling Ranges, 13 Nov. 1944, *R.J. Moir s.n.*; Tone River, Deeside Coast Rd crossing, 10 Nov. 1990, *R.W. Purdie* 4076 (CBG *n.v.*); Gull Rock Rd, (E of Albany), at Ledge Point turnoff, 24 Sep. 1982, *A. Strid* 20476; Bickley Reservoir, 8 Nov. 1978, *E. Wittwer* W2157 (CANB *n.v.*).

Distribution. South West Botanical Province, IBRA regions of Swan Coastal Plain, Avon Wheatbelt, Jarrah Forest, Warren and Esperance Plains. Extends from Gingin and Wongan Hills to the extreme south west of the state and east to the Stirling Range and Mt Manypeaks. (Figure 6D)

Habitat. Occurs bordering swamps and watercourses, on loam, clay or sandy soils in forest, woodland or shrubland.

Phenology. Flowers mostly September to December, occasionally March to May; fruits mostly December to February, falling quite quickly and rarely persisting to the next season.

Conservation status. Widespread and relatively common.

Affinities. Characterised by its widely spreading flat leaves and small clusters of small flowers. Similar to *Taxandria conspicua* subsp. *conspicua* from which it differs in leaf shape, flower cluster and flower size and in its less persistent fruits. *Taxandria conspicua* subsp. *conspicua* has narrowly elliptic to elliptic leaves that are very slightly concave above and convex below, flower clusters *c.* 10 mm across and larger flowers with petals 1.4–3 mm long. The infructescences of *T. conspicua* subsp. *conspicua* usually persist for 1 or 2 years whereas those of *T. linearifolia* have usually disintegrated by the following flowering season.

Hybrids. Possible hybrids with *T. parviceps* have been noted in several scattered localities – near Albany (*R.J. Chinnock* 3227), near Busselton (*A. Horan* 17 & *R.D. Royce* 3411), Kentdale (*J.R. Wheeler* 2665 & 2669), Kudardup (*G.J. Keighery* 1571), Milyeanup Nature Reserve (*R. Davis* 7560), Mount Barker (*K.F. Kenneally* 1225), Mullalyup (*N.F. Norris* 987), Muirillup Rock (*N.G. Marchant* 79/63) and Northcliffe (*L. Graham* 824).

Possible hybrids with *T. angustifolia* have been noted from the Porongurup Range (*I. Abbott s.n.*). Possible hybrids with *T. conspicua* subsp. *conspicua* have been noted from Last Bottle Rock.

Notes. The type locality, "Insulam Decres" (Kangaroo Island, South Australia), is regarded here as a label error. The specimen photograph from the De Candolle Herbarium (Prodr. 3: 227) is *Taxandria linearifolia* and is not known to occur east of Mt Manypeaks.

De Candolle (1841–42) illustrated *Leptospermum linearifolium* and it is presumably the same taxon as described earlier (De Candolle 1828). The illustration, that in all other respects agrees with *Taxandria linearifolia*, indicates 5 stamens in the floral diagram. However a longitudinal section of the flower illustrated shows 4 stamens in the half flower. It is likely that the floral diagram did not show all stamens that were present.

Taxandria linearifolia is a species with a variable leaf length. Long-leaved variants and short-leaved variants of *T. linearifolia* commonly grow together.

The species is documented as commonly resprouting after fire.

Taxandria marginata (Labill.) J.R. Wheeler & N.G. Marchant, *comb. nov.*

Leptospermum marginatum Labill., Nov. Holl. Pl. Sp. 2: 10, t. 148, (1806). – *Agonis marginata* (Labill.) Sweet, Sweet's Hort. Brit. ed. 2, 209 (1830). – *Billottia marginata* (Labill.) R. Br., *J. Roy. Geogr. Soc.* 1: 19 (1932). – *Billotia marginata* (Labill.) G. Don, Gen. Hist. 2: 827 (1832). *Type:* in terrâ Van-Leuwin [Western Australia], *Labillardiere* (*holo*: FI *n.v.*; *iso*: MEL 3398, 3399, ?P).

Leptospermum marginatum var. *glabratum* DC., Prodr. 3: 226 (1828). – *Billotia marginata* var. *glabrata* (DC.) G. Don, Gen. Hist. 2, 827 (1832). *Type:* "ex hort. Berol" (*n.v.*, photograph seen G-DC).

Shrub to 2(3) m high; branchlets softly hairy with spreading to somewhat appressed fine hairs. *Leaves* single, not clustered; petiole 1–5 mm long; blade obovate or broadly obovate to elliptic or broadly elliptic, more or less flat, 9–28 mm long and 4–10 mm wide, with 3–5 longitudinal veins, softly hairy when young, glabrescent or sparsely sericeous with long fine hairs and with a distinct band of appressed fine marginal hairs, base cuneate, apex obtuse or rarely obtusely acuminate. *Flower clusters* axillary or terminating short axillary shoots, 10–12 mm across, sterile basal bracts few. *Bract* broadly obovate to depressed obovate, 2–3 mm long, glandular-punctate and glabrous in lower half, hairy in distal half, ciliolate, apex obtusely truncate. *Bracteoles* narrowly obovate, distinctly laterally curved, 1.8–2.5 mm long and 0.5–1 mm wide, densely hairy in the distal half, apex obtuse. *Flowers* white -petalled, 5–9 mm across. *Floral tube* obconic, 2–3 mm long, glabrous proximally and hairy distally, slightly extended for up to 0.5 mm above the ovary. *Sepals* broadly ovate-triangular, 0.8–1.5 mm long, densely hairy, ciliolate, apex obtuse. *Petals* 1.5–3 mm long including a distinct claw *c.* 0.5 mm long. *Stamens:* filament 0.5–1 mm long; anther 0.2–0.4 mm long. *Ovary* summit glabrous or with hairs around base of style; ovules usually 2 per cell. *Style* 1.7–2.5 mm long. *Infructescence* globular to ellipsoid, 7–15(–20) mm long. *Capsule* cup-shaped to broadly turbinate, 2.5–3.5 mm across, glabrous in lower half and usually shortly hairy in distal half. (Figure 7A–E)

Selected specimens examined. WESTERN AUSTRALIA (all PERTH except where indicated): 14 km W of Walpole, Woolbales area, 13 Feb. 1985, *A.R. Annels s.n.*; Isthmus Hill, [Torndirrup National Park], 11 Apr. 1979, *D. Davidson s.n.*; North Point, Two Peoples Bay, 28 May 1964, *A.S. George* 6279; Cape Le Grand National Park, SW of Lucky Bay along walk to Thistle Cove, 14 Oct. 1991, *W. Greuter* 22809; Summit of Mt Hopkins, Walpole–Nornalup National Park, 15 Aug. 1979, *L. Haegi* 1806 (NSW *n.v.*); lower slopes of Mt Arid, above Thomas Fishery, Cape Arid, 11 June 1985, *G.J Keighery* 7781; Port du Roi-georges, *Leschenault* 102 (P); William Bay National Park, Jan. 1984, *C.V. Malcolm* 74; King George's Sound, Sep. 1840, Preiss 141 (LD, MO, NY); SW Plantagenet, Sep. 1901, *E. Pritzel* 325 (GH, MO, P, WRSL); Albany, 23 Feb. 1955, *R.D. Royce* 5007 (CANB, K *n.v.*); Mondrain Island, Recherche Archipelago, 6 Feb. 1960, *R.D. Royce* 6229; extreme SE of Hassell Beach, Cheyne Bay, 22 Feb. 1994, *J.R. Wheeler & N.G. Marchant* JRW 3893 (AD, MEL).

Distribution. South West Botanical Province, IBRA regions of Warren, Jarrah Forest and Esperance Plains. Disjunct distribution, it occurs from Chatham Island and the Woolbale Hills west of Walpole along the coast to Cheyne Beach and also between Esperance and Cape Arid and the islands of the Recherche Archipelago. (Figure 4C)

Habitat. Occurs in association with granitic outcrops or boulders in coastal or near-coastal heath or woodland.

Phenology. Flowers mostly February to August. Fruits appear September to December and persist for up to 12 months.

Conservation status. Widespread on coastal granite and often recorded as common or abundant and occurring in several national parks.

Affinities. Similar to *Taxandria conspicua* from which it differs in its broader leaves with a dense marginal fringe of hairs.

Hybrids. Possibly hybridises with *T. angustifolia* at Mt Manypeaks where specimens have been found that are intermediate in leaf characters (*D. Davidson s.n.*, *S. Barrett* 126G). Possible hybrids with *T. callistachys* have been recorded near Esperance (C.D. Turley 2/793), Cape Le Grand at Frenchman's Peak (*A.S. Weston* 8968) and Thistle Cove (*C.D. Turley s.n.*). An early collection from the Albany area (*B.T. Goadby* 59) is a possible hybrid with *T. parviceps*.

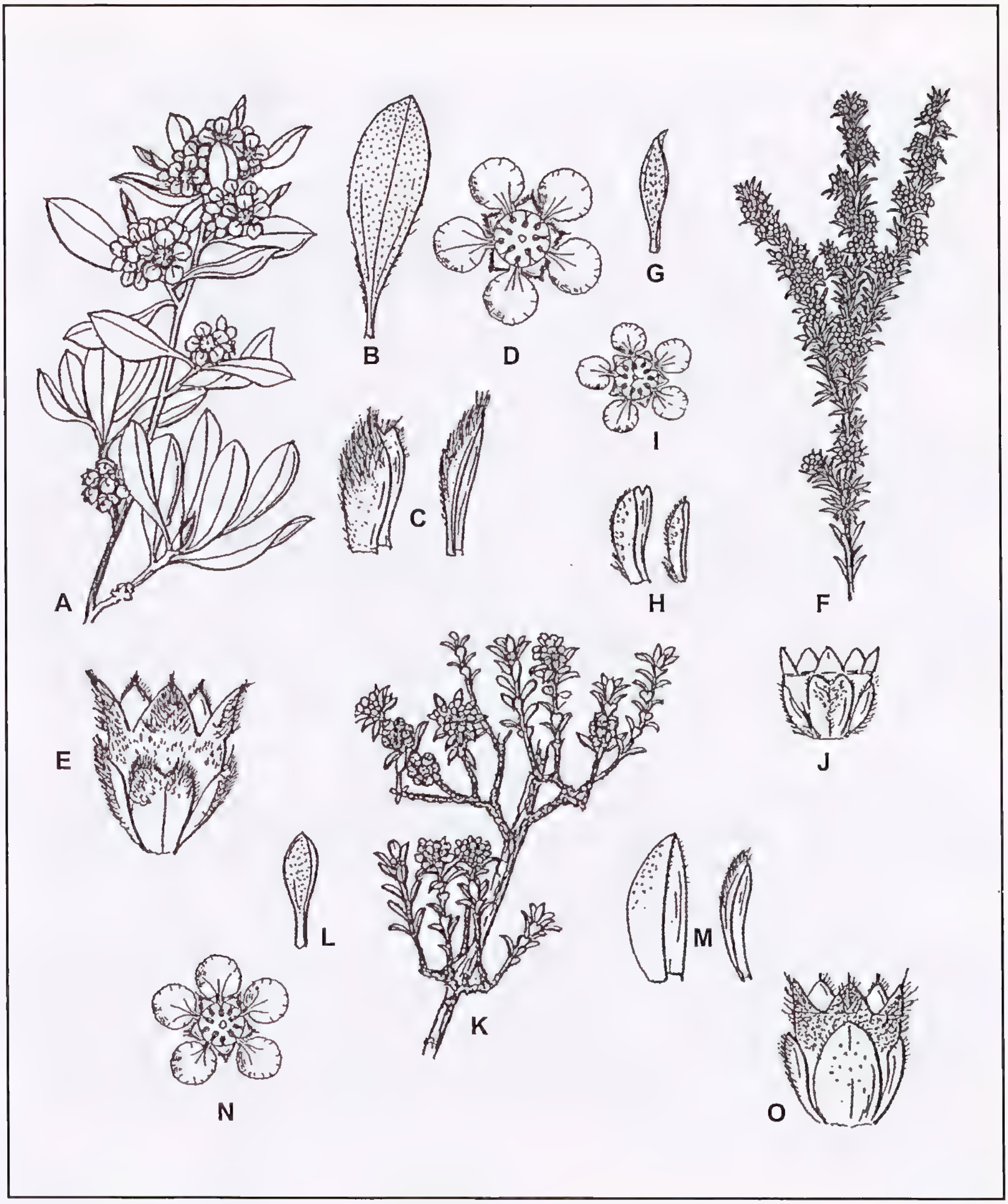

Figure 7. A–E. *Taxandria marginata*. A – flowering branch (×0.75), B – leaf (×1.5), C – bract and bracteole (×9), D – flower (×3), E – flower with petals removed (×6); F–J. *Taxandria parviceps*. F – flowering branch (×0.75), G – leaf (×1.5), H – bract and bracteole (×9), I – flower (×3), J – flower with petals removed (×6); K–O. *Taxandria spathulata*. K– flowering branch (×0.75), L – leaf (×1.5), M – bract and bracteole (×9), N – flower (×3), O – flower with petals removed (×6).

Taxandria parviceps (Schauer) J.R. Wheeler & N.G. Marchant, *comb. nov.*

Agonis parviceps Schauer in Lehm., Pl. Preiss. 1: 119 (1844). *Type:* "In clivulo arenoso inter frutices densos prope vicum Albany", [Western Australia], 25 September 1840, *Preiss* 160 (*lecto*: LD, here designated*; isolecto:* KW, MEL 3400, 3401, 3402, 3403). *Paralecto:* Dec. 1839 *Preiss* 161, 1822 *Cunningham s.n.*

Shrub, erect, to 3(–4)m high; branchlets terete, puberulous and pilose. *Leaves* usually in clusters forming short axillary shoots, rarely single, sessile, spreading to slightly recurved in distal half, narrowly obovate or narrowly elliptic, occasionally some leaves obovate to elliptic, thick, the upper surface flat to slightly concave, the lower surface slightly convex, 3–7(–9) mm long, 0.6–1.5(–2.5) mm wide, glabrous or occasionally minutely ciliolate particularly towards the leaf base, midrib only evident on the lower surface, apex obtuse to acute, often minutely bluntly apiculate. *Flower clusters* more or less globular, terminating short axillary shoots, sterile basal bracts few. *Bract* broadly obovate to almost circular, 1.2–2 mm long, 1–1.5(–2) mm wide, glandular-punctate, minutely hairy along the midrib and in the distal half, apex emarginate to obtusely 2-lobed. *Bracteoles* narrowly obovate to obovate, distinctly laterally curved, 0.8–1.5(–2) mm long, 0.7–1 mm wide, hairy particularly on keel and towards the apex, apex obtuse to emarginate or obtusely 2-lobed. *Flowers* white-petalled, 4–6 mm across. *Floral tube* 0.7–1.5(–2) mm long, glabrous or with irregular areas of sparse hairs, very slightly extended for up to 0.2 mm above the ovary. *Sepals* ovate-triangular, 0.5–1(–1.2) mm long, glabrous and minutely ciliolate or with sparse hairs in distal half, apex obtuse. *Petals* 1.5–2.2 mm long including a distinct claw 0.2–0.6 mm long. *Stamens*: filament 0.3–0.5 mm long; anther 0.2–0.3 mm long. *Ovary* summit glabrous; ovules 2 per cell. *Style* 1–1.8 mm long. *Infructescence* globular, *c.* 6 mm across. *Capsule* cup-shaped to broadly cup-shaped, 1.7–2.5 mm across, glabrous or hairy. (Figure 7F–J)

Selected specimens examined. WESTERN AUSTRALIA (all PERTH except where indicated): N summit area of Mt Lindesay (*c.* 27 km by road N of Denmark) Denmark State Forest, 11 Oct. 1989, *B.J. Conn & J.A. Scott* BJC3377 (CHR, MEL, NSW all *n.v.*); 10 miles [16 km] E from Alexandra Bridge, 2 Nov. 1978, *R.J. Cranfield* 954; Mt Clarence, Albany, 11 Oct. 1962, *A.R. Fairall* 569; Sunny Glen Rd, 10 km E of Denmark (off South Coast Highway), 4 Dec. 1985, *D.B. Foreman* 1464; Stirling Range National Park, W ridge of Bluff Knoll, 22 Oct. 1991, *W. Greuter* 23095; S side of SW Highway along a powerline right-of-way, *c.* 0.95 km W of junction with Coalmine Beach road, less than 1 km E of Walpole, 8 Oct. 1999, *J.W. Horn* 2800 (DUKE *n.v.*); Kirrup (*sic*), Oct. 1910, *M. Koch* 2073 (P); Coastal zone near Cape Beaufort, 40 km E of Augusta, 16 Sep. 1976, *R. Story* 8251 (CANB *n.v.*); between Busselton and Nannup, 13 Sep. 1962, *F.W. Went* 83; Nornalup Rd, near junction with Gum Link Rd, 10 Aug. 1991, *J.R. Wheeler* 2671; between Cowaramup and Margaret River, Warren District, 6 Nov. 1974, *D.J.E. Whibley* 5047 (AD *n.v.*); 24 km SE of Pemberton on road to Northcliffe, 1 Oct. 1967, *P.G. Wilson* 6281 (CANB *n.v.*).

Distribution. South West Botanical Province, IBRA regions of Swan Coastal Plain, Warren and Jarrah Forest. Occurs from near Dardanup throughout the extreme south west of the state as far east as Two Peoples Bay; also recorded north to the Porongurup and Stirling Ranges. (Figure 6E)

Habitat. Occurs in heath, shrubland, woodland or forest, often on the margins of seasonally wet areas, mostly on sandy soils and often forming quite dense thickets. In the Stirling Range the species has been recorded on heavier soils at rocky sites.

Phenology. Flowers mostly July to October with petals persisting for several months after anthesis; fruits November onwards and persisting for up to a year.

Conservation status. Widespread, often recorded as common or abundant and occurring in several national parks.

Typification. Preiss 160 from Lund herbarium is here chosen as the lectotype as it agrees with the protologue and was most likely to have been seen by the author.

Affinities. Similar to *T. inundata, T. angustifolia* and *T. linearifolia. Taxandria parviceps* is most similar to *T. inundata* in the shape of the bracts and bracteoles and in the recurved nature of the leaves. *Taxandria inundata* however is larger in all respects and has a denser indumentum, particularly on the sepals. Habit preferences and flowering times also differentiate *T. inundata* from *T. parviceps*.

Taxandria parviceps differs from *T. angustifolia* and *T. linearifolia* in leaf shape and size, as well as in bract and bracteole shape. *T. angustifolia* and *T. linearifolia* both have longer leaves, obtuse rather than emarginate bracts and obtuse to acute bracteoles.

This species differs from *T. juniperina* in its habit, bracts, bracteoles and sepals. *Taxandria juniperina* is a large tree of seasonally inundated areas with bracts and bracteoles that are glabrous or slightly hairy and obtuse to acuminate, and sepals that are acute and more or less glabrous. The two may grow relatively close to each other but *T. juniperina* always grows in much wetter situations while *T. parviceps* occurs in better drained areas that dry out more quickly in spring.

Hybrids. Taxandria parviceps commonly hybridises with other *Taxandria* species. Hybrids have been recorded with *T. linearifolia, T. conspicua* and *T. angustifolia* (see note under those species).

Taxandria spathulata (Schauer) J.R. Wheeler & N.G. Marchant, *comb. nov.*

Agonis spathulata Schauer in Lehm., Pl. Preiss. 1: 117 (1844). *Type:* "In glareosis sterilibus ad radices collium Konkoberup promontorii Cape Riche", [Mt Melville, Cape Riche, Western Australia], 19 November 1840, *Preiss* 324 (*lecto*: LD, here designated; *isolecto*: MEL 976).

Shrub to 2 m high, sometimes spindly, erect to spreading or procumbent, the main stems often thick; branchlets terete, somewhat hairy with long and often curled hairs. *Leaves* single not clustered, spathulate; petiole usually distinct, 0.5–1.5 mm long, shortly hairy; blade broadly to very broadly obovate, elliptic or almost circular, flat to very slightly concave above and convex below, often somewhat recurved towards apex, 2–6 mm long and 1.5–5 mm wide, glabrous apart from marginal hairs at least when young, venation not apparent or only the base of the midrib apparent on lower surface, very abruptly tapered at base, apex obtuse. *Flower clusters* terminal or terminating short shoots, hemispherical to globular, 8–10 mm across, sterile basal bracts few. *Bract* very broadly ovate to very broadly obovate, 1.5–2.5 mm long, glandular-punctate and verrucose, glabrous but ciliolate, apex very obtuse. *Bracteoles* narrowly oblong to narrowly obovate and laterally curved, 1.5–2 mm long and 0.5–0.7 mm wide, densely hairy down keel, ciliolate, apex obtuse. *Flowers* white-petalled, occasionally with pinkish claws, 4–8 mm across. *Floral tube* 1.5–2.5 mm long, extending up to 1 mm beyond the ovary surface, glabrous or with sparse hairs in distal half, often wrinkled or somewhat ribbed. *Sepals* ovate-triangular, 0.7–1 mm long, with sparse coarse hairs particularly towards apex, apex subacute to more or less obtuse, ciliolate. *Petals* 2.5–3.5 mm long including a distinct claw 0.5–1 mm long. *Stamens*: filament 0.3–0.6 mm long; anther 0.2–0.3 mm long. *Ovary* summit often with sparse short hairs around style; ovules 2 per cell. *Style* 1.4–2 mm long. *Infructescence* globular, (5–)7–8 mm across, the shoot usually continuing to grow. *Capsule* turbinate to cylindric, 2–2.5 mm across, glabrous or rarely with sparse hairs in distal half. (Figure 7K–O)

Selected specimens examined. WESTERN AUSTRALIA (all PERTH except where indicated): 25 km NE of junction of Ethel Daw Drive and Elverdton Rd, 12.5 km SE (by road) of Ravensthorpe, 14 Oct. 1989, *B.J Conn & J.A. Scott* BJC3404 (E, MEL, NSW *n.v.*); corner Old Ongerup Rd and Pingrup Rd, E of Gnowangerup, 16 Oct. 1986, *E.J. Croxford* 5233; 1849, *J. Drummond* 5: 131 (P); *c.* 14 km E of the mouth of the Oldfield River, Shire of Oldfield, 12 Oct. 1968, *Hj. Eichler* 20190 (AD *n.v.*); Cape Riche, 11 Oct. 1942, *C.A. Gardner* 6539; Fitzgerald River National Park, between Middle Mt Barren and Mt Drummond road, junction with telegraph line, 24 Sep. 1970, *N.G. Marchant* 70/453; Cape Le Grand National Park, 21 Oct. 1969, *R.D. Royce* 8615; Mt Ragged [Cape Arid] National Park, Roe District, 8 Sep. 1983, *J. Taylor & P. Ollerenshaw* JT1546 (AD, CBG, MEL *n.v.*); Dunn Rock Nature Reserve 36445, 25 Sep. 1995, *S. Walsh* 35 (CANB *n.v.*); Stirling Range National Park, Red Gum Pass, 11 Nov. 1991, *J.R. Wheeler* 2920 (CANB); 3 km W of Bremer Bay township, 1 Sep. 1966, *P.G. Wilson* 4318.

Distribution. South West Botanical Province, IBRA regions of Jarrah Forest, Avon Wheatbelt, Mallee and Esperance Plains. Occurs from the Stirling Range east to Israelite Bay, extending north to near Lake King. (Figure 6F)

Habitat. Occurs in a variety of habitats, most commonly on sandy soils in heath, shrubland, mallee-heath or woodland.

Phenology. Flowers mostly September to October; fruits November onwards, the fruits persisting for up to two years.

Conservation status. Widespread, often recorded as common or abundant and occurring in several national parks.

Typification. Of the two type specimens seen, the LD specimen is chosen as the lectotype because it matches the protologue and is the one most likely to have been seen by Schauer.

Hybrids. No hybrids have been recorded involving *T. spathulata* despite its frequent cohabitation with *T. conspicua* subsp. *abrupta* in Fitzgerald River National Park.

Paragonis J.R. Wheeler & N.G. Marchant, *gen. nov.*

Genus novum, *Agoni* (DC.) Sweet affinis, sed floribus solitariis (vel inflorescentiis paucifloris) per bracteis imbricatis subtensis, staminibus longioribus in annulo continuo dispositis differt.

Type: Paragonis grandiflora (Benth.) J.R. Wheeler & N.G. Marchant.

Shrubs. *Leaves* spirally arranged in clusters forming short axillary shoots, sessile, glandular-punctate, concolorous. *Inflorescence* of solitary flowers or few-flowered clusters terminating or in the upper axils of short shoots; each flower or cluster subtended by several imbricate basal bracts and each individual flower subtended by a broad bract and 2 larger broad bracteoles. *Floral tube* adnate to the ovary and very slightly extended upwards above the ovary, glandular-punctate. *Sepals* 5, broadly elliptic to broadly ovate, hooded, glabrous, persistent. *Petals* 5, spathulate to obovate and gradually tapered to the base, not persisting. *Stamens* free, variable in number, 22–35 in a single continuous whorl; filament slender; anther versatile and dorsifixed, 2-celled, dehiscing by longitudinal slits, the connective with a small globular gland. *Ovary* inferior, 3-celled, each cell with 3–6 ovules. *Style* sunken in a central depression of the ovary; stigma capitate and disc-like. *Fruit* a 3-celled woody capsule. *Seeds* black, more or less ellipsoid but slightly compressed, *c.* 1.5 mm long, with dense white hairs, usually only 1 maturing per cell, the remainder similar but withering early.

Distribution. A monotypic genus endemic to the south-west of Western Australia.

Etymology. Derived from Greek, *para* – alongside, close by, beside and *Agonis*, referring to the morphological similarity with *Agonis*.

Paragonis grandiflora (Benth.) J.R. Wheeler & N.G. Marchant, *comb. nov.*

Agonis grandiflora Benth., Fl. Austral. 3: 10 (1867). *Type*: Hampden, [Western Australia], *W. Clarke* (*holo*: K; *iso*: MEL 80031).

Shrub to 1.7 m high, erect and often straggly, multi-stemmed; branchlets sparsely to densely hairy with spreading and often curled hairs when young but glabrescent. *Leaves* in spirally arranged clusters forming short axillary shoots, sessile, linear but often somewhat semiterete, flat or concave above and convex below, 5–20 mm long and 0.5–1.2 mm wide, with spreading hairs when young, glabrescent, sometimes with sparse marginal hairs, venation not apparent, scarcely tapered at base, apex acute and shortly mucronulate. *Inflorescence* spike-like with short axillary spike-like leafy flowering shoots, flowers solitary or 2 or 3 together terminating or in the upper axils of extremely short axillary shoots. *Bracts: outer sterile bracts* subtending flower cluster or single flower transversely broadly ovate, 1–3 mm long and 3–4 mm wide, apex obtuse and often minutely apiculate; *inner fertile bract* elliptic, broadly elliptic, broadly obovate or circular, 3.5–5 mm long and 3–4 mm wide, glabrous, with a thin paler membranous margin, apex obtuse and often apiculate. *Bracteoles* obovate to broadly obovate or elliptic-obovate, 3.5–5.5 mm long and 2–4 mm wide, concavo-convex, glabrous, with a thin paler membranous margin, apex very obtuse and often minutely apiculate. *Flowers* usually white-petalled, often suffused pink, 12–17 mm across. *Floral tube* 3–4 mm long, often hairy in distal half, extended above the ovary for *c.* 0.5 mm. *Sepals* broadly elliptic to broadly ovate and somewhat hooded, 2–3 mm long, glabrous, central area slightly glandular-punctate, margin thinner and somewhat inrolled, apex acute to subacute. *Petals* spathulate to obovate, 6.5–8 mm long in total, gradually tapered to the base, sparsely glandular-punctate, apex obtuse. *Stamens* 22–35, forming a continuous whorl; filament variable in length, 2.5–4 mm long, incurved; anther *c.* 0.5 mm long. *Ovary* summit glabrous; ovules 3–6 per cell. *Style* 4–5 mm long. *Capsules* solitary or 2 or 3 together, broadly cup-shaped, 2.5–3 mm long, 3–3.5 mm wide, glabrescent. (Figure 8A,B)

Selected specimens examined WESTERN AUSTRALIA (all PERTH except where indicated): [locality uncertain], Oct. 1936, *W.E. Blackall* 3991 (CANB *n.v.*); Gavins Rd, 8.9 km E of Elgin Rd, W of Donnybrook, 22 Oct. 1997, *R. Davis* 4422; Barrington Quarry, 24 Sep. 1987, *H. Demarz* 11845; Harvey, Oct. 1943, *C.A. Gardner s.n.*; Fairbridge Farm School, Pinjarra, 13 Nov. 1931, *C.A. Gardner s.n.*; Ellis Brook, Darling Scarp, Gosnells, 1 Nov. 1971, *A.S. George* 11161 (CANB, K, MEL, NSW all *n.v.*); Victoria Forest Block, suburb of Martin, Gosnells, the SW corner of Victoria Reservoir catchment, 26 Jan. 1999, *F. Hort* 387; 4 km SE of North Dandalup on Dwellingup road, 24 Oct. 1980, *G.J. Keighery* 3468; Crooked Brook Rd, Boyanup to Dardanup, 6 June 1983, *G.J. Keighery* 6142; E of Boyanup, Crooked Brook Rd, 2.8 km E from Ironstone Rd (Ferguson Rd) turnoff, Darling District, 11 Nov. 1990, *R.W. Purdie* 4098 (CBG *n.v.*).

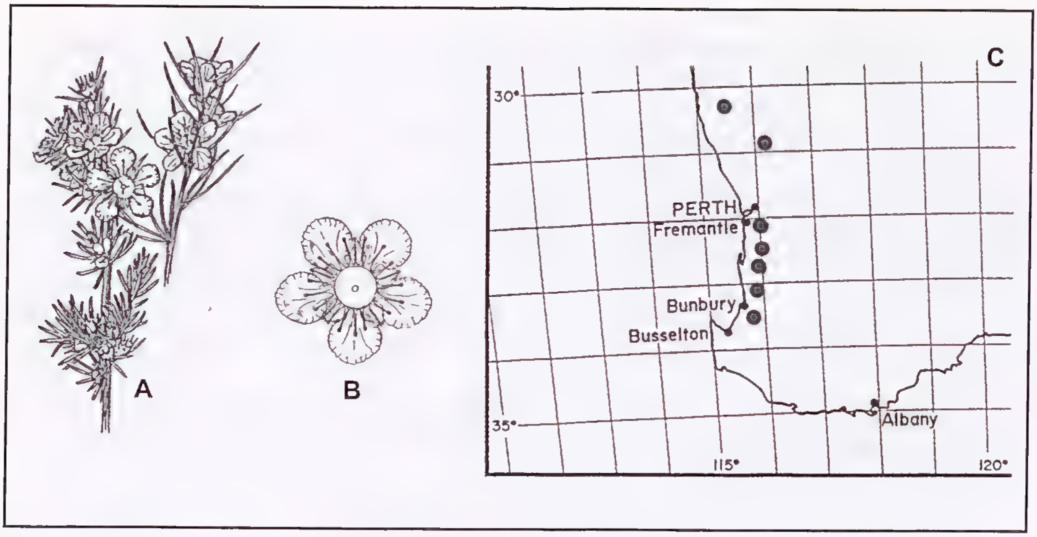

Figure 8. *Paragonis grandiflora*. A – flowering branch (×0.75); B – flower (×2); C – distribution.

Distribution. South West Botanical Province, IBRA regions of Avon, Swan Coastal Plain and Jarrah Forest and doubtfully from Geraldton Sandplains. The species occurs along the Darling Scarp extending from Piawaning south to near Boyanup, with an additional but dubious locality given as ?Badgingarra (*L. Steenbohm s.n.*). (Figure 8C)

Habitat. Occurs in eucalypt woodland and scrub on granitic, lateritic and doleritic soils.

Phenology. Flowers mainly September to November, but also recorded in January; fruits November to January but persisting for only a few months after seed is shed.

Conservation status. Restricted to a few localities on the Darling Scarp. Not currently considered to be endangered..

Affinities. *Paragonis grandiflora* differs from *Agonis* and *Taxandria* in its flowers being solitary or in 2- or 3-flowered clusters, each cluster or single flower surrounded by conspicuous bracts. It has larger flowers and the stamens are in a continuous whorl with staminal filaments almost twice the length of those found in *Agonis* or *Taxandria*.

List of excluded names

The following names do not form part of this study as they refer to eastern Australian taxa now considered to belong to *Astromyrtus*, *Leptospermum* and *Sinoga* (name derived from "agonis" in reverse). Refer to the Australian Plant Names Index (http://www.anbg.gov.au/cpbr/databases/apni.html).

Agonis abnormis C.T. White & W.D. Francis
Agonis elliptica C.T. White & W.D. Francis
Agonis elliptica Sweet
Agonis elliptica var. *angustifolia* C.T. White & W.D. Francis
Agonis elliptica var. *elliptica* C.T. White & W.D. Francis
Agonis ericoides F.M. Bailey
Agonis longifolia C.T. White & W.D. Francis
Agonis luehmannii (Bailey) C.T. White & W.D. Francis
Agonis lysicephala (Bailey) F.M. Bailey
Agonis ovalifolia Sweet
Agonis scortechiniana F. Muell.
Agonis speciosa (Schauer) C.T. White

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Puccinellia (Poaceae) in Western Australia

Alexander R. Williams

c/o Western Australian Herbarium, Department of Environment and Conservation,
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983

Abstract

Williams, A.R. *Puccinellia* (Poaceae) in Western Australia. *Nuytsia* 16(2): 435–467 (2007). Two new native species, *Puccinellia longior* and *P. vassica*, have been identified from Western Australia. *P. longior* is restricted to the outer edges of salt lakes and salt-affected pasture land along the lower western margin of the southwest wheatbelt region in WA, and has also been collected from a saline wetland reserve in southeast South Australia. *P. vassica* is endemic to the outer edges of marine saltmarsh in reserved areas of the Leschenault Inlet near Bunbury. It was previously known from the nearby Vasse-Wonnerup saltmarsh near Busselton but is now extinct there because engineering works have reduced the marine influence in the estuary. It may be on the verge of extinction in the Leschenault Inlet also because (a) it lives on the outer edge of the high tide influence and is thus prone to weed invasion from non-saline areas, (b) its culms disintegrate almost entirely each year so it provides little resistance to competition, and (c) it has a low recruitment rate, with only a few scattered plants surviving at each site. The most common species is *Puccinellia stricta*, which occurs on the margins of salt lakes and salt-affected pastoral land throughout the southwest wheatbelt region, from Hutt River in the north to the Esperance region in the east. WA collections of this species differ from those elsewhere in southern Australasia, but in a continuous way that did not easily yield taxonomic distinction. The main source of variation is probably that the WA habitats all have to endure long summer drought each year. The agriculturally introduced Middle-Eastern species *P. ciliata* is well naturalized in saline lands in southwest WA, and a single collection of the introduced *P. gigantea* is recorded. Other introduced species appear to have not survived.

Introduction

Puccinellia Parl. (Poaceae) is a cosmopolitan genus of more than 90 salt-tolerant species that occur from the Canadian Arctic islands in the northern hemisphere to the sub-Antarctic Macquarie Island in the southern hemisphere. Amongst its Asian members, *P. tenuiflora* Scribner & Merr. was recently chosen as a model organism for studying the molecular biology of salt tolerance for use in bioengineering of monocotyledonous plants (Wang *et al.*, 2006), and some experimental progress has already been made (Soumin *et al.*, 2004). There may thus be some potential for application of this research to our Australian conditions through our native *Puccinellia* species.

When this study began in 2003 only one native species was recorded from Australia, together with three introduced species. Edgar (1996) provided a review of *Puccinellia* in New Zealand and offshore islands and this was the only available in-depth treatment of the genus in the Australasian region. Recent Australian Flora treatments included Walsh & Entwisle (1994), Jacobs & McClay (1993) and Jessop and

Toelken (1986), and South African grasses had been described by Gibbs Russell *et al.* (1990). Walsh (1991) published a note and a new name needed for the *Flora of Victoria*, and Weiller (N. Walsh pers. comm.) had prepared a draft report on the genus for volume 44A of the *Flora of Australia*.

Puccinellia species are generally restricted to the margins of saline wetlands or to salt-affected lowlands. In Western Australia the genus is restricted to the southwest, principally the inland agricultural zone. A wide range of *Puccinellia* collections was introduced to Western Australia from the Middle East in the 1950s, 60s and 70s by agricultural authorities, to ameliorate salt-affected land. The purpose of this present work was to establish the status of the native species in WA, in association with the Biological Survey of the Wheatbelt (Keighery *et al.* 2004) a part of the State-sponsored Salinity Action Plan, and to confirm the identity of the introduced collections at PERTH, many of which were identified only to genus.

Taxonomic History of *Puccinellia* in Western Australian

In Gardner's *Flora of Western Australia – Gramineae* (1952) just one species of *Puccinellia* was recorded, the native *P. stricta*. It was originally described by Hooker (1853) as *Glyceria stricta*. The lectotype (Allan & Jansen, 1939) is *Gunn* 1463 from a (salt) marsh at Launceston, Tasmania, held at K (sheet K000348683 carries the site and collector details and sheet K000348684 carries the illustrations for *Glyceria stricta* that appeared in Hooker's *Flora of Tasmania*, 1860). The species was transferred to *Puccinellia* by Blom (1930). It was the only native species recorded from Australia when this study began, and was also the most widespread species within the genus in both Australia and New Zealand. However, the specimen used by Gardner to illustrate his 1952 *Flora* (Plate XXVIIIB) has now been assigned to a new native species endemic to the southwest of WA, *P. vassica* A.R.Williams.

Steudel (1854), almost contemporaneously with Hooker's publication, described *Glyceria tenuispica* Steud. from a Drummond collection (V, 347) from WA. In Mueller (1872–1874), *G. tenuispica* is included, along with Mueller's earlier *Poa syrtica* and Hooker's *Glyceria stricta*, in the synonymy of *Festuca syrtica*. Bentham (1878) reasserted the priority of *G. stricta* and included Mueller's two names as synonyms, while *G. tenuispica* is also mentioned, not in synonymy, but in a note on the distribution of *G. stricta*. The single Gardner specimen at PERTH from Busselton was annotated by Hubbard in 1937 suggesting that it might be *Glyceria tenuispica*. I can find no other references to *G. tenuispica* in published literature. A specimen at MEL of *Drummond* 347 carries an undated annotation in Mueller's handwriting '*Glyceria tenuispica* Steudel. [then underneath] *Festuca syrtica* FvM var. *patens*, W.A. Drum. 347.' The varietal name seems not to have been published by Mueller. The Kew sheet of *Drummond* V, 347 (K000347908, high resolution image seen) carries a note from P. Jansen identifying it as '*Puccinellia stricta* var. *tenuispica*,' a combination which Jansen apparently never published. Both the MEL and K specimens of *Drummond* 347 fit *P. stricta* and in the analysis that follows I have included *G. tenuispica* as a synonym of that name.

Two varieties of *P. stricta* have been recognized in Australia (Walsh 1991) – var. *perlaxa* (from Victoria) and var. *stricta*, and three infraspecific taxa have been recognized in New Zealand (Allan & Jansen 1935) – var. *suborbicularis*, forma *luxurians* and forma *pumila*. However Edgar (1996) found that the species in New Zealand was so variable that it was not possible to delimit subgroups within it and left open the question of whether the Australian and New Zealand populations were taxonomically distinct. Hooker (1853) examined specimens from New Zealand and Tasmania and said of the latter "they are much larger than the New Zealand ones but not otherwise different".

Only one alien species, *P. ciliata,* had been recorded as naturalized in Western Australia but this and two others, *P. distans* and *P. fasciculata,* had been recorded as naturalized in the eastern states. All of these were probably the result of deliberate introductions. In 1951 Miles and Donald brought seed of a salt-tolerant species from Turkey and planted it at the CSIRO field station at Kojonup (WA) with a view to using it in reclamation of salt-damaged farming land. This species—presumably, as it was cited by Tan (1985) as having come from Australia and having been widely used in Western Australia for reclamation of saline areas—was originally identified as *P. capillaris* (Liljebl.) Jansen. A later collection of the material grown at Kojonup was determined by Bor (1968) to be a new species – *P. ciliata* Bor. Note that Bor (1968) cited the type specimen of *P. ciliata* as coming from Turkey but correspondence at PERTH shows that it came from the Turkish material cultivated at Kojonup. The details are given in Tan (1985).

The quest for reclaiming salt damaged land was then taken up by the WA Department of Agriculture. C.V. Malcolm and others collected salt-tolerant plants from many parts of the world in the 1960s and 70s. Malcolm *et al.* (1984) listed the following *Puccinellia* accessions (with the number of accessions, from various locations, in brackets): *Puccinellia airoides* (1), *P. capillaris* (1), *P. ciliata* (10), *P. distans* (10), *P. fasciculata* (2), *P. maritima* (4), *P. retroflexa* (1), *P. rupestris* (1), *P. stricta* (2) and *Puccinellia* sp. (72). Their accessions of *P. stricta* and *P. ciliata* were not introductions but were collected from sites in WA. All of their accessions labelled '*Puccinellia* sp.' were collected from sites in Turkey and Iran. Twenty-seven voucher specimens of the material from Turkey were lodged at the WA Herbarium. Amongst these voucher specimens, 22 were labelled *Puccinellia* sp. and of these I have determined 7 as *P. ciliata*, 12 as *P. distans*, 1 as *P. gigantea*, 1 as *P. grossheimiana*, and one was indeterminate because all the spikelets had fallen. Two of their voucher specimens were labelled *P. distans*, which I was able to confirm, and one was labelled *P. capillaris,* which I determined to be *P. ciliata*.

At the commencement of this study little was known about the distribution, abundance or conservation status of native *Puccinellia* in Western Australia, especially in light of the widespread planting of introduced taxa. However, recent collections were becoming available, especially as a result of the Wheatbelt Biological Survey (Keighery *et al.* 2004). Further collections were made as a result of preliminary findings of the study reported here.

Taxonomic Considerations

Puccinellia is widely regarded as a "difficult" genus. Some investigators recognize few species while others recognize numerous species. Davis (1983, 1988) studied phenotypic plasticity in the genus in order to identify the most useful kinds of morphological characters to use in taxonomy. He found that variation in both genotype and phenotype within the genus was "continuous in distribution and highly variable in magnitude". In an attempt to resolve this problem Choo *et al.* (1994) carried out a molecular study of a range of *Puccinellia* species from the northern hemisphere, together with representatives of the related genera *Phippsia*, *Sclerochloa* and *Catabrosa*. Their conclusions were that:

- *Puccinellia* was resolved as monophyletic,
- *Puccinellia, Phippsia*, *Sclerochloa* and *Catabrosa* are all genetically distinct genera,
- only two species groups were resolved within *Puccinellia*, each supported by only one character (i.e. most of the species were not distinguishable using the molecular characters studied),
- North American and Eurasian species of *Puccinellia* were not clearly separated,
- only 2 of the 21 *Puccinellia* accessions in the study were diploid, 19 were polyploid; the 2 diploid species were thought not to have been the full ancestors of the polyploids,

- "if additional data support the present resolution, or one much like it, major portions of the genus, distributed widely across both northern continents, might best be regarded as one or a few complexes of barely differentiated species, or perhaps as a mosaic of polymorphisms within which any species delimitations would be artificial" (p. 125).

Consaul & Gillespie (2001) studied diagnostic characters in Canadian Arctic Island *Puccinellia* species. Amongst 10 named species they were able to clearly distinguish 6 species or species aggregates but their multivariate study showed an "almost complete lack of distantly separated groups [which] revealed the quantitative morphological similarities and overlap amongst [all] the species" (p.950).

When these observations were added to those recorded above by Edgar (1996) for *P. stricta* it seemed wise to adopt a broad, rather than narrow, view of taxonomic delineations within the genus.

Methods

Useful Characters from the world literature

Different character suites appear to be useful in different floras. To identify the material from Turkey as well as that in Australasia, I compiled a list of species, characters and character states from the keys used by Tan (1985) and Davis et al. (1988) in Turkey, and Jessop & Toelken (1986) and Simon (1993) in Australia, with additional data taken from Hubbard (1984) and Walsh & Entwisle (1994). These characters were scored as a DELTA dataset for all the species occurring in Turkey and in Australia, and the interactive computer program INTKEY (Dallwitz *et al.*, 2000) was used to identify specimens in the PERTH collection and loan specimens.

Useful characters from the Australasian collections

The character list resulting from the above study was found to give inadequate attention to the structure of the panicle, and the work of Vegetti and Anton (2000) on panicle structure suggested further characterisation was required.

Grass Panicle Morphology. Recent discoveries in developmental biology (Carroll 2005) show that genes do not generally operate alone but as part of large gene complexes, and they operate (only) by being switched on and off. These 'switches' are located on the DNA strand near to the gene they control. One gene may be involved in a dozen or more different stages during development and will have a separate switch for each stage. When a gene is switched on, it affects development from that point onwards, but not anything before that point. Thus, during panicle development, 'choices' made early will influence and perhaps preclude (or allow) certain later choices, but later choices will not affect earlier ones.

For example, if peduncles are short and the number of spikelets and/or the number of branches per node is large, then the angle they can assume in relation to the panicle axis is controlled by spikelet crowding rather than by an intrinsic property of the peduncle itself. It is only when peduncles are long that a choice of spreading angle is possible. On the other hand, if peduncles are long, then the number of spikelets per node and the number of branches per node have no influence on branching angle and are then (only) independent characters. Exsertion of the panicle from the leaf sheath is also correlated with panicle branch angle because the wider branch angles can only be achieved in the exserted condition.

Swelling of pulvini (axillary glands) causes panicle branches to diverge from the erect position. In some collections, pulvini appear to be absent, but do appear later at seedfall and cause some branches to expand. But in other collections the pulvini are swollen and obvious before divergence occurs, so the two characters (presence of pulvini and panicle expansion) are not necessarily completely correlated.

The arrangement of spikelets along the panicle branches is quite complex and is not well characterised by the two states used in the literature 'branches naked in proximal half or third' or 'at least some branches bearing spikelets to the base.' Rather, the arrangements form distributions of various kinds, and indeed the lateral branches of the grass panicle are now thought to be independent flowering units (Vegetti and Anton 2000) so it may be misleading to think of the panicle as a single organ. This is consistent with the gene-switching concept in that once a lateral branch gene complex is switched on, it will affect only characters downstream on that branch alone.

According to Vegetti and Anton (2000), the ancestral grass inflorescence is a panicle consisting of a series of alternating lateral 'flowering units' and ending in a terminal flowering unit. The flowering unit consists of a main florescence (spikelet) plus co-florescences that include short paraclades (a branch ending in a single spikelet) and long paraclades (branches that branch again and then end in spikelets). The ancestral condition is thought to be alternating flowering units, so the quasi-whorled condition in *Puccinellia* would be a derived state produced by reduction in the length of segments of the main axis. This appears to be confirmed by a few rare cases where an aberrant panicle has disjunct branching, compared with the standard kind of branching for the genus where all branches at a node arise from approximately the same point on the main axis.

According to the Vegetti-Anton theory, each lateral branch is an independent flowering unit and should be individually scored for its characteristics. In practice, however, it is often difficult to see the structure of individual branches if the number of branches and/or the number of spikelets per node is large and the spikelets are densely crowded together. It seemed more reasonable to look for summary measures such as minimum, maximum and/or mode (the most commonly occurring value) at each node, and to describe the spikelet arrangement in terms of the shape of its distribution. The important variation in panicle morphology is most easily summarised in describing just the two lowest nodes, but to see these in the enclosed state, the panicle needs to be dissected out of its sheath (i.e. cut the culm just above the second leaf collar and slide the panicle *down* through the flag leaf sheath).

The following characters were thereby defined (the number of panicle characters was matched to the number of spikelet characters, to balance their relative contributions to the similarity measures in the numerical analyses):

- *Number of spikelets per node*; the branches all (usually) emerge from a single point on the main panicle axis (here called a 'node'), so this character was simply the total number of spikelets on all branches at that point. In rare cases, two groups of branches will emerge slightly disjunct; in this case the internode has not fully developed so I either sought another specimen, or used the next node up (if it was similar) or scored just one of the disjunct groups of branches.
- *Spikelet distribution laterally per node*; the mode (the peak of the spikelet distribution) can be *proximal* (most of the spikelets crowded near the main axis), *even* (similar numbers at different distances from the axis), or *distal* (long bare peduncles with spikelets mainly at or near the ends).

- *Peduncle length*; a peduncle is the stalk of an inflorescence and the traditional view is that the whole panicle is the grass infloresence, but according to Vegetti & Anton (2000) each lateral branch is an independent inflorescence, so the stalk of each lateral branch up to the point of the first subsequent branch point is here defined as a peduncle. These lengths at each node vary a lot and are hard to measure when crowded together so the minimum and maximum lengths at the two lowest nodes were used (the lowest node can differ greatly or only a little from the second node). Only the length from the main axis to the first branch point was used.
- *Lateral Branch length*; maximum length of all lateral branches (mean of the two lowest nodes).
- *Panicle shape* at anthesis included three states: *contracted* (branch angle 0–45°), *spreading* (some branches up to 90°) and *deflexed* (some branches up to 180°). The spreading characters can only be achieved in the exserted state, so the correlation noted earlier is implied in these states. However, the exserted/enclosed state was retained as a separate character to cover the uncorrelated combination—'exserted and contracted'.
- *Crowding of spikelets*. The estimated number of spikelets per millimetre in the proximal third of the lateral branches at each of the two lower nodes was used as an index of crowding in the quantitative analyses. It was calculated as $C = ND/B$, where N is the number of spikelets per node, D is a function of the distribution type (taking continuous values of 1/3 for an even distribution, 2/3 for a proximal distribution, and 1/6 for a distal distribution)[1], and B is the maximum branch length. In the DELTA key and descriptions (where the user cannot calculate the output of a function), a visual estimate of crowding was used—whether or not spikelets overlap one another on panicle branches or are crowded together near the node.

Spikelet Characters. Number of florets per spikelet can vary either a great deal or only a little, and vary with distance either up or down, within a single panicle. In the most variable cases the number increased up the panicle, and the terminal spikelet had as many as 10–12–14 florets while the lowest had only 2–5. Furthermore, in some species and/or specimens, the innermost spikelets in the lower panicle branches were undeveloped. In some specimens, the terminal floret in a spikelet was developed and either male or bisexual, but in other specimens the terminal floret was aborted. No taxonomic significance was attached to any of these variable conditions, and spikelets taken for dissection were selected from the middle of the panicle. Number of spikelets per floret was reported as found.

There was little useful variation in glume shapes in the WA species, but this became significant in comparison with exotic species. Lower lemma indumentation varied significantly from glabrous to ciliate, as did the callus. Palea keels were always scabrous in the upper third, but varied in the lower half, being either glabrous, scabrous or ciliate. Anther colour varied from creamy white (with a purple tinge in some species) to rusty brown.

Character Scoring. For the purposes of the numerical analyses, non-numerical characters (e.g. presence/absence) were treated as ordered multistate characters and given positive non-zero values so that intermediate conditions made numerical as well as botanical sense. For example, lemma nerves were scored as either 'prominent' or 'obscure' but sometimes different lemmas on the same plant might show both conditions, or some lemmas might have an intermediate condition. By scoring 'obscure' as 1, and 'prominent' as 2, then the intermediate condition could be given a value of 1.5, or other such fraction as might reflect the situation.

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[1] The actual formula used to obtain a continuous function was $C = N(4/(2^D))/B$.

Specimen selection. Since panicle shape at anthesis was identified as an important character, specimens for the Australasian numerical study were selected so that they were all at approximately the same stage of development and in sufficiently good condition that all relevant measurements could be made upon them. Where possible, only specimens determined by well-known authors were used. Four geographically isolated provinces were sampled across the range of *P. stricta*: Western Australia, eastern Australia, Tasmania, and New Zealand.

Multivariate Analyses

Multivariate analyses were carried out to check the consistency and accuracy of the data, and to assess relationships between specimens and taxa using all the available information rather than just depending upon the character by character analysis that results from the INTKEY procedure. Two complementary kinds of methods were used, cluster analysis (using both Ward's method and the Paired Group method), and ordination (using Principle Coordinate Analysis), both kinds implemented by the program PAST (v.0.78, 2002, http://palaeo-electronica.org/2001_1/past/main.htm).

In Principle Coordinate Analysis (PCoA), the items are represented as points in an n-dimensional space, where n is the number of characters. The distance between each item and every other item is thus the distance between their two points in the n-space. The PCoA method extracts a set of axes that represent the data more efficiently than the original character axes. The first two of these axes are then used to plot the points in two dimensions so that we can see what the major pattern in the data looks like. Similar items appear close to one another on the resulting two-dimensional plot, but it should be remembered that there is unrepresented variance also present in the data so two points that are close in two dimensions may be separate on the third or fourth dimensions.

A clustering algorithm is a convenient way of overcoming the problem of the unrepresented variance in the PCoA plots. In Ward's method, cluster membership is assessed by calculating the total sum of squared deviations between items and cluster means. The criterion for fusion is that it should produce the smallest possible increase in the residual sum of squares. To avoid the bias that would result from the different measurement scales used for different characters, the data were normalized before analysis so that all characters have the same variance (as a result, all the numbers range around a mean value of about 1). Normalization is not required for PCoA as it is inherently catered for in the method. In the Paired Group method, clusters are built from the bottom up by joining the most closely similar items; the distance matrix (calculated as Euclidean distance) is then recalculated so that the distance between clusters is the mean of the distances between all their members.

While neither ordination nor clustering can produce a 'best' representation of multivariate data, the two methods can be used in combination in such a way that each makes up for the shortcomings of the other. Ordination is good at showing the overall pattern of distant relationships in the data, but not the close relationships. On the other hand, clustering is good at showing close relationships, but not good at showing distant relationships. For example, all items are forced to join a cluster eventually so some items can end up clustered together simply because they do not resemble any other item even though they may differ greatly from each another.

The list of characters and their states is given in Table 1. The original specimen data are too voluminous to list here, but are lodged on a CD in Excel and in plain text format with the PERTH herbarium library (WALIB Accession No. 623367).

Type Specimens

Relevant loan specimens were requested and a variety of responses were received, ranging from actual specimens, to on-line images, to high resolution images on CD. Type specimens cited were seen unless otherwise indicated with 'n.v.', 'image seen', or 'high-resolution image seen.'

Species Descriptions

In 2003, the PERTH collection was comprehensively examined using a character set compiled from the literature cited earlier, brought together in a DELTA database. This process yielded a new

Table 1. Characters, states and units of measurement (in DELTA format) used in the multivariate study of native and introduced *Puccinellia* species in Australia. Measurements were made on dry specimens. Explanatory comments are in square brackets.

#1. Habit/
1. caespitose/
2. stoloniferous/
#2. Duration/
1. annual/
2. perennial/
#3. Culm height/
mm/
#4. Leaf <below flag leaf> blade length/
mm/
#5. Leaf <below flag leaf> blade <shape>/
1. involute/
2. more or less flat/
#6. <Leaf below flag leaf blade stiffness>/
1. erect/
2. flaccid/
#7. <Leaf below flag leaf blade> width/
mm/ [measured as is on dried specimens]
#8. Ligule <on leaf below flag leaf> length/
mm/
#9. Panicle shape/
1. contracted at flowering time (may spread later)/ [<45°]
2. spreading at flowering time/ [up to 90°]
3. spreading, some branches deflexed/ [>90° to 180°]
#10. Panicle length/
mm/
#11. Panicle branch surface/
1. smooth (or almost so)/
2. scabridulous/
#12. Panicle <in relation to flag leaf>/
1. enclosed by flag leaf/
2. exserted above flag leaf/
#13. Number of lower panicle branches per node/
#14. Spikelet distribution on lower panicle branches/
1. crowded near the base of lateral branches/
2. evenly spread/
3. mainly at the ends of long bare peduncles/
#15. Spikelets per node (mean of lower two nodes)/
#16. Spikelets <crowding on panicle branches>/
1. not overlapping one another on panicle branches/
2. overlapping one another on panicle branches/
3. crowded together near the nodes/
#17. Minimum peduncle length/
mm/
#18. Maximum peduncle length/
mm/
#19. Maximum branch length/
mm/
#20. Spikelet length/
mm/
#21. Number of florets per spikelet/
#22. Lower glume length/
mm/
#23. Upper glume length/
mm/
#24. Glume tips/
1. entire/
2. erose/
#25. Lemma tip <shape>/
1. tapering/
2. blunt/
#26. Lemma length/
mm/
#27. Lemma nerves/
1. obscure/
2. prominent/
#28. Lemma midnerve <whether excurrent>/
1. not extending to the margin/
2. extending to the margin, sometimes excurrent/
#29. Lemma indumentum/
1. glabrous/
2. sparse hairs near base/
3. ciliate/
#30. Palea length/
mm/
#31. Palea indumentum/
1. glabrous in lower half/
2. scabrous or ciliate in lower half/
#32. Callus hairs/
1. glabrous/
2. ciliate/
#33. Anther length/
mm/
#34. Anther colour/
1. creamy white/
2. creamy white with purple tinge/
3. rusty brown/

species, *Puccinellia longior*, here described. Edgar (1996) had raised a question over the relationship between Australian and New Zealand populations of *P. stricta*, and the characterization of *P. longior* in its Australasian context seemed a good opportunity to address that question. Relevant loan specimens were acquired and a selection, as outlined earlier, was studied in depth using the revised character list given in Table 1, and the data were used in the multivariate analyses. After the analyses were all completed, the data from the specimens was used to re-structure the DELTA database to reflect just the material I had examined. The descriptions appearing below were generated from that database so they are all based on my observations and measurements, but having been compared with relevant literature values for potential anomalies (such as the one noted below for anther length in *P. distans*).

Results

Determinations amongst PERTH collections. In general, the exotic specimens fitted the key data (based on published information) quite well, with one exception. Amongst the twelve specimens from Turkey and the one from each of Algeria and Tunisia that are labelled *P. distans,* all had anther lengths in the range 1–1.5 mm, compared to the literature values of 0.5–1mm. When this anomaly first appeared, I excluded anther length from the INTKEY determinations but found that the specimens still keyed out to *P. distans* on the other characters. Since this was the only character that separated this material from *P. distans*, and no other candidate name was obvious, I chose to expand the anther length range of *P. distans* up to 1.5 mm long. In reviewing this decision at the end of the study, I noted that anther length was a very important character in the genus generally, and further inquiry was warranted.

Table 2. Identification of PERTH collections.

Species	WA	Other Aust.	Turkey	Other
**P. ciliata*	17		7	
**P. distans*		NSW (2)	12	Algeria (1), Tunisia (1)
**P. fasciculata*		SA (1)		
**P. gigantea*	1		1	
**P. maritima*				UK (1)
**P. grossheimiana*			1	
P. stricta	27	Victoria (1)		
P. longior sp. nov.	7			
P. vassica sp. nov.	7			
P. perlaxa		NSW (1)		

A study of the frequency of anther length over all the data in the study showed a distinct bi-modal distribution, with the first mode at 0.7 mm, and the second at 1.5 mm. This could perhaps reflect an underlying mechanism that, on average, doubles the time that the anther growth gene complex is switched on during embryonic development, or perhaps a gene duplication or polyploid event that doubles the amount of growth promoter produced. I examined further specimens of *P. distans* from England, Sweden and New Zealand, and found that these all had anther lengths in the literature range of 0.7–1.0 mm. I then did a multivariate analysis on all the specimen data together. Both cluster methods linked up all the *P. distans* specimens together, separate from any other grouping, but closest in each case to *P. fasiculata*. I conclude that *P. distans* was introduced to WA from the Middle East, but the specimens varied from the standard description in having longer than usual anthers. But since none of this introduced material appears to have survived in the field, I have retained the literature values for *P. distans* anther length at 0.7–1.0 mm.

Table 3. Identification of the Middle Eastern voucher material at PERTH.

Williams names	Malcolm names		
	Puccinellia sp.	*P. distans*	*P. capillaris*
Puccinellia sp.	1 (no spikelets)		
P. ciliata	8		1
P. distans	14	2	
P. gigantea	1		
P. grossheimiana	1		

Amongst the vouchered introduced species, *P. ciliata* has successfully naturalized in WA, but *P. distans* and *P. grossheimiana* have failed to naturalize.

Amongst the field collections of native or apparently naturalised material from Western Australia, *P. gigantea* was a new (single) record for the State, and two new native species *P. longior* and *P. vassica* were discovered. The multivariate analyses described in the Methods section were used to characterize these new taxa within the Australasian context and to decide upon their rank.

Multivariate analyses

Western Australian Collections. The results for the PCoA method, using all characters but just the Western Australian native collections, are shown in Figure 1. The three closest-knit groups produced by Ward's method of clustering are outlined. There is a clear separation between all the members of the groups labelled *longior* and *vassica* from the main body of the *P. stricta* collections. The ranks of these taxa were assessed as follows.

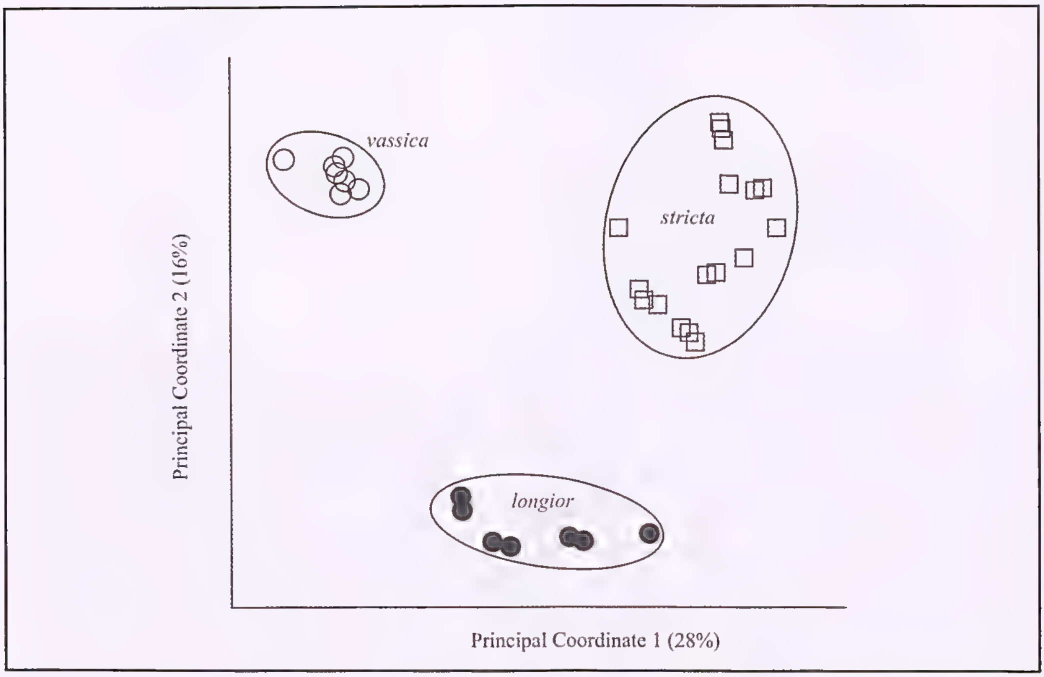

Figure 1. Principal Coordinate Analysis plot of Western Australian native specimens of *Puccinellia* using all the character data as listed in Table 1. Both clustering methods produced the same three groups (outlined), which consist of two new species, *P. longior* and *P. vassica*, and the Australia-wide *P. stricta*. The percentage variation accounted for by each coordinate is given in brackets.

Puccinellia longior displays its claim to species rank with very distinctive morphological features, but it also has a distinctive geographical distribution. The major morphological distinctions are in the anthers and ligules. The anthers are long (1.1–1.7 mm compared with 0.5–0.9 mm in *P. stricta*), linear and rusty brown coloured (both before and after dehiscence) compared with ovate and creamy white in *P. stricta* (before and after dehiscence). The ligules are consistently and considerably longer than in *P. stricta* (3.3–4.8 mm compared with 1.0–2.3 mm). Inspection of the species descriptions shows that *P. longior* is larger than *P. stricta* in many aspects in WA, and is comparable in size to the largest specimens of *P. stricta* from elsewhere in Australasia.

The very narrow east-west distribution of *P. longior* follows the line of drainage transition between ancient drainage surface inland and rejuvenated drainage surfaces along the west and south coast, as shown in Figure 2. This is quite remarkable given that *P. stricta* occurs throughout the whole wheatbelt region. The restricted distribution of *P. longior* to this southern drainage corridor may mean that it is only mildly tolerant of salt and grows only in areas that are flushed with flowing surface water during the winter wet season. In view of the rising salt levels in this area the species could thus be at risk of extinction.

Puccinellia vassica. A distinctive specimen of *Puccinellia* was collected from Busselton by Pries in 1870, and another of the same taxon by Gardner in 1936. Gardner used his specimen to illustrate *P. stricta* in his 1954 *Flora of WA* Vol. 1 Gramineae, Plate XXVIIIB. However, no further *Puccinellia* collections have ever been made from the Busselton area, and nothing quite like the Busselton collections has subsequently been collected from anywhere else in WA.

Unfortunately, no site data was given for either of these specimens, but the most likely saline habitat in that area was the marine salt marshes of the Vasse-Wonnerup inlet along the coast. *Puccinellia stricta* is widespread across Australasia, and occurs around salt lakes right through the WA wheatbelt, but there are no salt lakes in the Busselton area. Drummond's collection 219 from Western Australia, lodged at MEL (likewise with no site data given), also matched the Busselton collections and very likely came from that area also.

A search of the area was therefore carried out in November 2005 but all such sites in the Vasse-Wonnerup wetlands were heavily weed-infested and/or converted to pasture as a result of floodgates having been installed to mitigate seawater inflow during the dry summers (Brearley 2005, Ch. 4). However, north of Busselton, we found a few similar specimens, sparsely distributed, at small sites in Bunbury and in two reserved areas of the Leschenault Inlet. According to Figure 1, these seven specimens are all uniquely similar to one another and quite different to the other native *Puccinellia* specimens in WA.

The distinctive characteristics of the group include a long ligule (2.5–5 mm, compared with 1–2.3 mm for *P. stricta* var. *stricta*), glabrous lemmas and callus, paleas glabrous for most of their length and only having a scabrous upper quarter. Spikelets are very crowded on short glabrous peduncles, with a large number of spikelets per node. No other *Puccinellia* have been collected from marine salt marsh in WA, even though small areas of it exist around inlets and estuaries all around the south-west and south coast (see Brearley 2005). The combination of morphological and geographical distinctiveness clearly gives the taxon species rank.

Identification of *P. vassica* requires some comment on C.E. Hubbard's annotation '*Glyceria tenuispica*' on the Gardner specimen of 1936. As mentioned earlier, Steudel raised the name *Glyceria tenuispica* from Drummond collection V no. 347, a duplicate of which is at Kew, (K000347908).

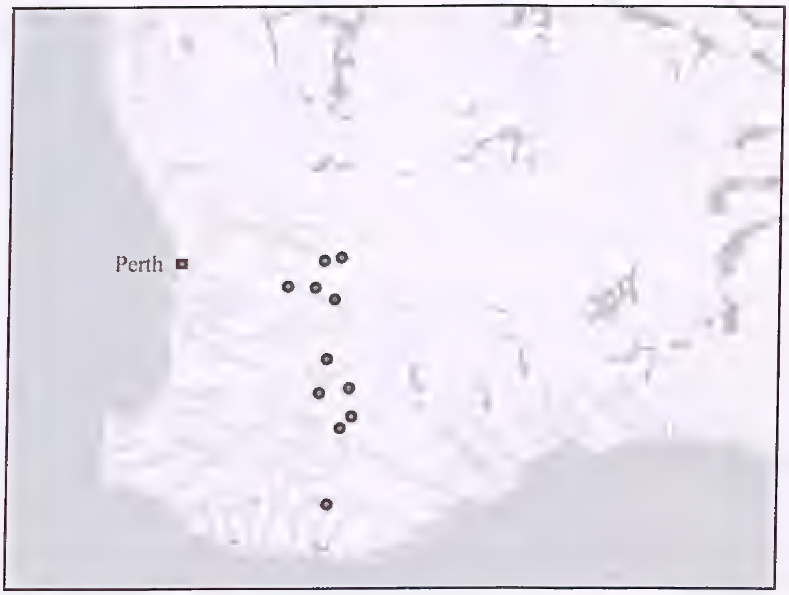

Figure 2. Distribution of *Puccinellia longior* in relation to drainage systems in Southwest Western Australia.

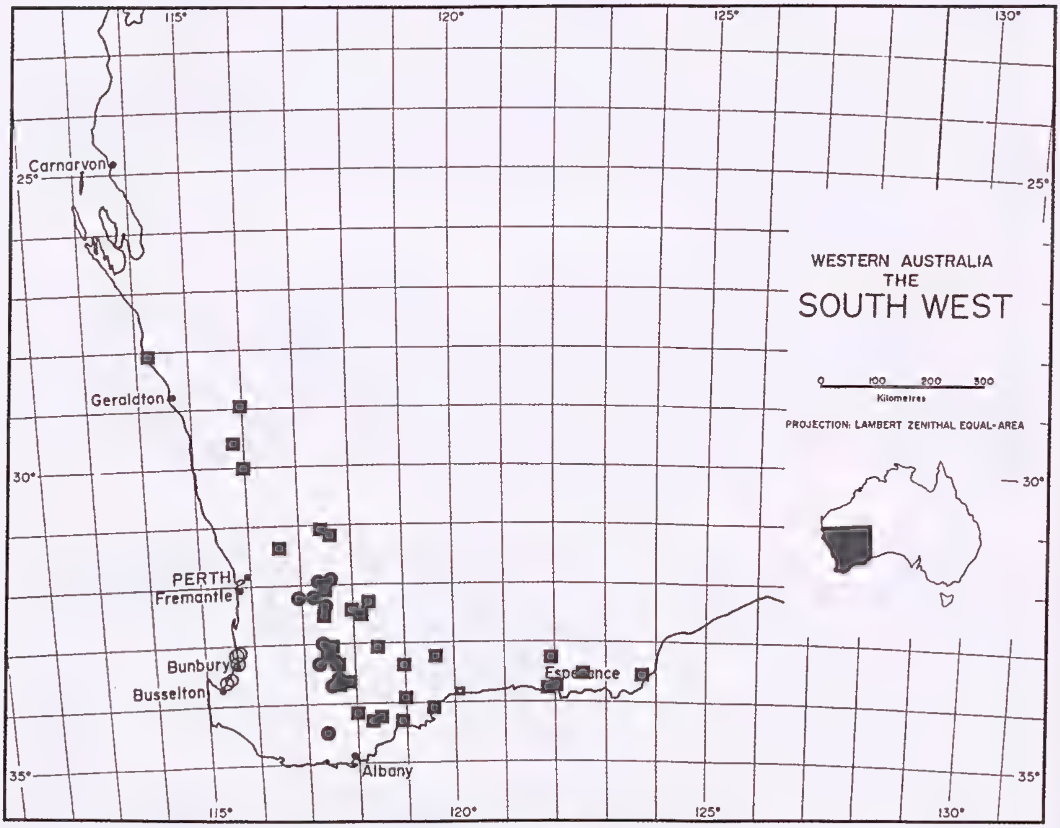

Figure 3. Distribution of *Puccinellia stricta* ▣, *P. longior* ● and *P. vassica* ○.

From a high resolution image of this sheet, I have determined it to be *Puccinellia stricta* var. *stricta*. Drummond collected it during his trip to the Stirling Range, Pallinup River, Mt Barren Range and Cape Riche area in 1849 and so it is likely that he found it on the margin of an inland salt lake, and not in the marine salt marshes of the Geographe coast where *P. vassica* occurs. Hubbard's note is thus now somewhat misleading. I have included *Glyceria tenuispica* as a synonym of *Puccinellia stricta* in the taxonomic section below.

The distributions of all three native taxa in WA are shown in Figure 3.

Australasian study of *Puccinellia stricta*

To answer the question of how *P. stricta* from WA compares with collections from elsewhere in Australasia, a selection of loan specimens from three other geographically separated regions (eastern Australian mainland, Tasmania, and New Zealand) were examined and the ordination plot is presented in Figure 4. Two well-separated groups were identified in the cluster analyses, and they show that the *P. stricta* var. *perlaxa* specimens are all quite unlike anything else. I showed this result to Neville Walsh, the author of *P. stricta* var. *perlaxa*, and he agreed that it clearly deserves species rank, so we have in this paper elevated it to *Puccinellia perlaxa* (N.G. Walsh) N.G.Walsh & A.R. Williams.

The *P. perlaxa* specimens were then removed from the *P. stricta* group, and the data re-analysed, this time using only spikelet and panicle characters to eliminate the environmental influence inherent

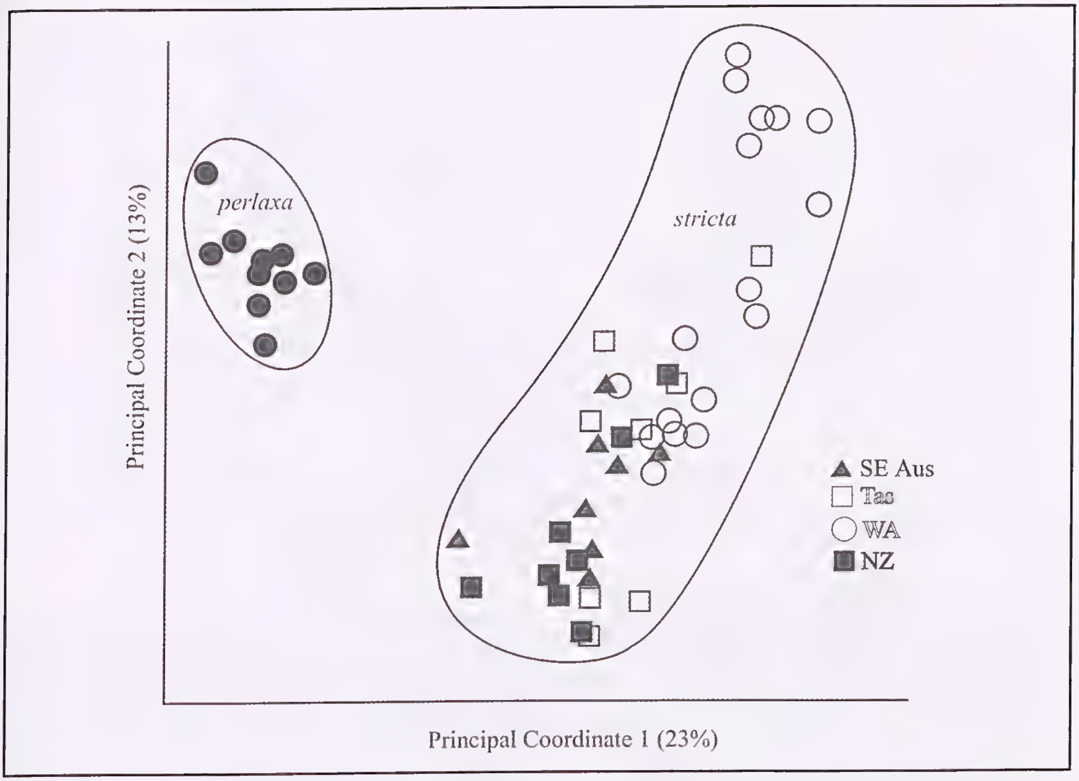

Figure 4. Principal Coordinate Analysis plot for *Puccinellia stricta* collections from across Australasia. Both cluster methods yielded the same two groups (enclosed by lines) separating *P. perlaxa* from all the others, thus supporting its elevation to species rank. The variation accounted for in each coordinate is given in brackets.

in the vegetative characters; the result is plotted in Figure 5. The collections are symbolized by region of origin, and the three type collections (Hooker's *Glyceria stricta, Gunn* 1463 from Tasmania, and Mueller's two 1847 collections of *Poa syrtica* from South Australia) are identified. There is a continuum of variation across these regions and no outstanding groupings were identified in the cluster analyses as in the previous cases. The WA material all segregates at one end of the plot, suggesting that they are somewhat different to other collections. The taxon descriptions given below were therefore separated into WA collections and 'south eastern Australia and New Zealand' (SEANZ) groups to show where the main variations occur. The WA collections are on average much smaller plants and this is most likely due to the generally drier environment—inland salt lakes and saline areas that are typically dry throughout the summer, compared with mostly coastal habitats elsewhere with generally wetter summers.

Edgar (1996) noted that *P. stricta* in New Zealand showed a wide range in character variation, notably the height of the plant and the shape of the panicle. Under extreme conditions the plants may become "very stunted", and Edgar quoted a height range of (2.5)–10–50–(65) cm which I have also observed. Edgar described the panicle to be "at first narrow linear, … at flowering … often still enclosed near the base, … later more open with ± spreading branches, .. usually completely free from the uppermost [leaf] sheath at maturity". Most of the WA collections had the panicle enclosed or closely subtended by the flag leaf sheath and only a few showed the later spreading at maturity and exsertion beyond the flag leaf.

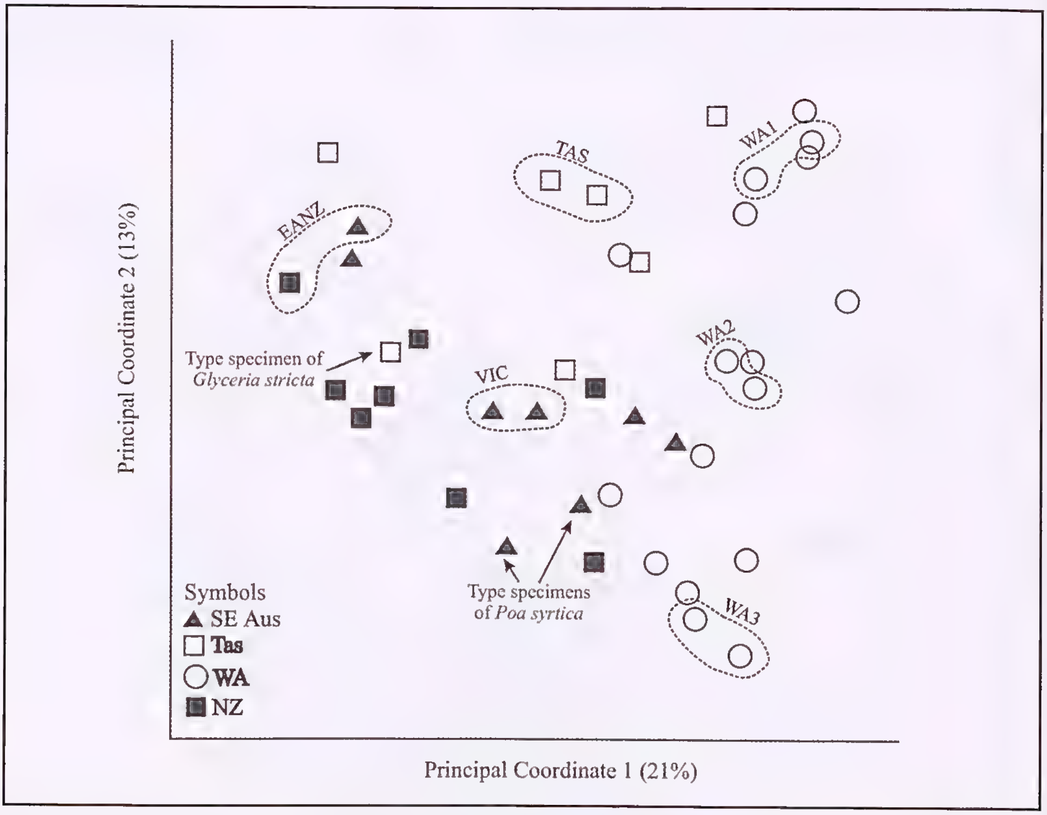

Figure 5. Principal Coordinate Analysis plot of *Puccinellia stricta* specimens from across Australasia, including three Type specimens. Only spikelet and panicle data were used, as listed in Table 1. There is a continuum of variation. Pairs of specimens that were the most closely clustered together are outlined and labelled, and their averaged character values are compared with those of the Type specimens in Table 4.

To illustrate the range of variation represented in Figure 5, the characteristics of the six most similar pairs of specimens (determined by both cluster analyses) are compared in Table 4 with the values for both Hooker's and Mueller's TYPE specimens and for the 'Species A' characteristics suggested in an earlier draft treatment of *Puccinellia* in Australia (Sharp & Simon 2002).

Table 4. Important characters amongst specimen groups (identified in Figure 5) from across the Australasian range of variation in *Puccinellia stricta*. Type 1 from Hooker's specimen, Type 2 from Mueller's specimens, and Species A was a suggested subgroup in earlier work. Bold entries are statistically significantly different from the median of the nine (or eight) groups.

	Specimen Groups								
Characters	**WA1**	**WA2**	**WA3**	**EANZ**	**VIC**	**TAS**	**TYPE 1**	**TYPE 2**	**Species A**
panicle exsertion	enclosed	enclosed	**exserted**	enclosed	enclosed	enclosed	enclosed	enclosed	enclosed
panicle shape	**open**	contracted	contracted	contracted	contracted	contracted	contracted	contracted	contracted
panicle length	88	63	44	**273**	120	75	125	112	150
spikelets per node	29	10	8	**38**	**42**	23	15	15	
branches per node	7	4	3	7	5	6	5	3	
ped. length min	1	1	1	**3**	2	2	1	1	
ped. length max	10	5	4	**29**	12	12	9	6	
branch length max.	33	26	12	**83**	53	40	35	23	
crowding index	**1.2**	0.5	0.7	0.5	0.8	0.6	0.4	0.6	
florets/spikelet	7	**10**	6	7	8	7	6	6	**9**
spikelet length	6.3	6.9	5.5	8.2	7.8	7.0	7.0	6.0	7.7
lower glume length	1.4	1.3	1.3	1.9	1.7	1.6	2.0	2.0	2.2
upper glume length	2.2	2.0	1.8	3.0	2.6	2.8	3.2	2.5	2.9
lemma nerves	**prominent**	**prominent**	obscure	obscure	obscure	**prominent**	obscure	obscure	**prominent**
lemma length	2.7	2.3	2.4	3.1	2.5	3.3	**3.6**	2.9	2.8
lemma indumentum	**v. hairy**	**hairy**	**hairy**	glabrous	**hairy**	**hairy**	glabrous	glabrous	**hairy**
palea length	2.5	2.2	2.2	**2.9**	2.4	2.6	3.0	2.3	2.4
anther length	0.7	0.7	0.7	0.8	0.7	**0.9**	**0.9**	0.7	0.8
leaf blade	**flat**	**flat**	rolled	rolled	rolled	rolled	rolled	rolled	rolled
leaf blade	**flaccid**	**flaccid**	stiff	stiff	stiff	stiff	stiff	stiff	stiff
blade width	**1.3**	1.0	0.7	0.9	0.8	0.6	0.6	0.7	**2.0**
blade length	108	40	40	**198**	118	68	75	117	100
ligule length	2.0	1.3	1.5	2.3	2.3	1.4	1.5	1.9	2.0
culm height	188	133	143	**650**	380	205	355	300	380
habit	annual	annual	annual	**perennial**	annual	**ann./per.**	annual	annual	annual

Significant deviations from the average values in Table 4 were determined using a median range test[2] and they are marked in bold. Mueller's Type specimens do not significantly deviate from the group average in any characters, while Hooker's Type specimen only deviates in minor ways. This suggests that indeed we are looking at a fairly Normally distributed suite of specimens relative to these Type specimens. On the other hand, every group differs from the average in two or more characters, so no group is exactly like the Type specimens. The EANZ group differs in 9 characters, the WA groups differ in 2, 5 and 7 characters, the Victorian group differs in 2, and the Tasmanian group differs in 4 characters. The WA material is therefore not the most deviant amongst these groups.

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[2] The median range test assumed that the values for each character were Normally distributed and that the confidence interval for the sample median was estimated by the range from the median to the nearest extreme value. This range was then applied towards the furthest extreme from the median, and any values outside this range were marked as significantly deviant.

WA1. This pair has panicles with one or more expanded branches, as well as some unexpanded branches having prominently swollen axillary glands (pulvini) suggesting that expansion may be imminent. The spikelets are crowded, and the lemmas have prominent nerves and hairs. The leaves tend to be flat and flaccid rather than involute and stiff.

WA2. This pair is similar to the previous, but with the standard contracted panicle, and smaller in nearly all size characters. They both come from seasonally dry inland saline lakes.

WA3. This pair is more similar to the Type specimens, deviating only in having an exserted panicle and hairy lemmas, but smallest of all in most dimensions, with very narrow panicles carrying fewest branches and spikelets per node. They both come from near-coastal saline lakes but at the two extremes of the north-south distribution of the species in WA—one from Utcha Spring nature reserve, just north of Hutt Lagoon in the north, and the other from Yellilup swamp near Bremer Bay in the south.

EANZ. This pair is the most deviant, being physically the largest in most dimensions, and perennial, coming from a higher rainfall region.

VIC. This pair is nearest of all to the Type specimens, differing only in having hairy rather than glabrous lemmas and more spikelets per node.

TAS. This pair is again very similar to the Type specimens, differing qualitatively in having hairy lemmas with prominent nerves, and one member was perennial.

Some WA and other Australian specimens of *Puccinellia* carry an annotation from C.M. Mihaich (now Weiller) '*Puccinellia* sp. aff. *stricta*.' These specimens were referred to an unnamed 'Species A' in Weiller's draft report on the genus in Australia (N. Walsh, pers. comm.) and she recommended further study, particularly of the WA material. The key characters suggested to distinguish it from *P. stricta* were 'lemma nerves prominent, lemma papillose, palea bidentate,' to which Neville Walsh added in an annotation to the draft 'lemma very broadly obtuse to nearly truncate, often bidentate or ruminate (c.f. lemma broadly acute to obtuse, mostly entire).'

Table 4 shows that prominent lemma nerves and hairs are widespread in the *P. stricta* groups, so this is not a useful distinction. I found the lemma tips to vary a great deal in the material I examined and did not persist with it as an informative character. The bidentate (as opposed to entire or bifid) palea was not a condition that either I nor Neville Walsh could reliably identify. As a result, I suggest that, as Table 4 indicates, the values represented for 'Species A' do not differentiate it from *P. stricta.*

If further study of *Puccinellia stricta* were to be carried out, then the WA collections would be the best place to start because they are geographically isolated from the eastern collections, and Figure 5 indicates that (a) they all fall towards one end of the first coordinate, and (b) they show the widest divergence on the second coordinate.

To identify environmental factors that correlate with this wide range of morphological variation, a good starting point would be the floristic survey of the wetlands of the wheatbelt region by Lyons *et al.* (2004). They found *P. stricta* (the study was done before *P. longior* was identified as a separate species) in just one out of 22 types of species assemblage, and that species assemblage occurred in eight out of 39 site groupings identified amongst 913 field sampling sites from throughout the wheatbelt. The *P. stricta* species assemblage was widespread, largely halophyte-dominated, and characteristic of the margins of saline wetlands and disturbed areas. Their statistical model identified soil pH and gypsum content, local elevation, winter cold and amount of summer rain as significant predictors of the species assemblage's occurrence. However, *P. stricta* was rarely more than a minor component of the vegetation and most of the populations consisted of annuals.

Plant size variations

The WA species of *Puccinellia* reflect the most likely causes of the size variations that we see in *P. stricta* right across Australasia. *P. vassica* plants are generally at the large end of the scale for the genus, and they come from the outer edges of marine salt marsh where soil moisture is perennially high and the plants have deep roots. *P. longior* plants are also on the large side, and they also occur in areas that are seasonally well watered. However, *P. stricta* exhibits the greatest range in plant size and comes exclusively from inland salt lakes or salt-affected lowlands that regularly dry out in summer. Their habitat is thus consistently subjected to severe water deficit and corresponding high salt concentrations. I infer that the stunted habits are simply the result of these environmental factors as demonstrated experimentally for other *Puccinellia* species by Davis (1983), and have no taxonomic significance. Growth trials under different salinity regimes would provide evidence that could be useful to test this notion.

Relationship between WA collections of *P. stricta* and other species

To test the possibility that the WA collections of *P. stricta* might be similar to either an introduced species, or to a sibling species of *P. stricta* in New Zealand, a multivariate analysis was carried out including relevant data for *P. walkeri*, the closest of the NZ endemic taxa to *P. stricta,* together with a variety of other native and exotic species for which we have comparable data (*P. vassica, P. longior, P. perlaxa, P. harcusia, P. ciliata, P. gigantea, P. grossheimiana, P. distans, P. fasciculata, P. maritima*).

The PCoA analysis placed *P. walkeri* at the same end of coordinate 1 as the *P. stricta* group, but both cluster methods grouped *P. walkeri* most closely with *P. maritima*, a marine saltmarsh species from the northern hemisphere that does not occur in Australia, so it is clearly distinct from *P. stricta.* Both cluster methods put the WA collections in the *P. stricta* group. In this group, the Tasmanian and New Zealand collections were the most similar; they were then joined by the southeastern Australian mainland group, with the WA group joining last.

Variation in *Puccinellia ciliata*

Bor (1968) distinguished *P. ciliata* from its nearest relative *P. gigantea* with "the lemma is completely glabrous on the dorsal surface while the keels of the palea are long ciliate in the lower half". Tan (1985) contradicted both these claims after re-examining types and other material determined by Bor. The isotype of *P. ciliata* at PERTH (00985422) is consistent with Tan's criticism and even has some palea keels glabrous in the lower half. This suggests that *P. ciliata* may not be a separate taxon. Tan retained *P. ciliata* however by saying that glume lengths were distinctly different, citing a range of 0.8–1.2 mm for the lower and 1.5-2 mm for the upper glume in *P. gigantea* and 1.5–2 mm and 3–3.5 mm for *P. ciliata*. In our PERTH material the upper and lower glume length ranges for *P. ciliata* are 1.2–2.0 mm and 2.0–3.5 mm respectively so the two ranges are contiguous.

To examine the difference between *P. ciliata* and *P. gigantea* more comprehensively I carried out a Principal Coordinates Analysis on just the spikelet data for our PERTH collections of these species together with the average values from Tan (1985). The points formed a complete continuum from the average values cited by Tan for *P. gigantea* through to the average values for *P. ciliata* and beyond. And there was no clear difference between the material from Australia and that from Turkey, except in the number of florets per spikelet.

The number of florets per spikelet for *P. ciliata* quoted by Tan was 8–11, but all our material had consistently fewer, ranging as low as 4–5. Tan noted a tendency towards lower values in cultivated specimens, and the Australian material has all been selected for agricultural use. I noted earlier that considerable variation in this character can occur just within a single panicle in *P. stricta*, so I am reluctant to place any taxonomic significance upon it here.

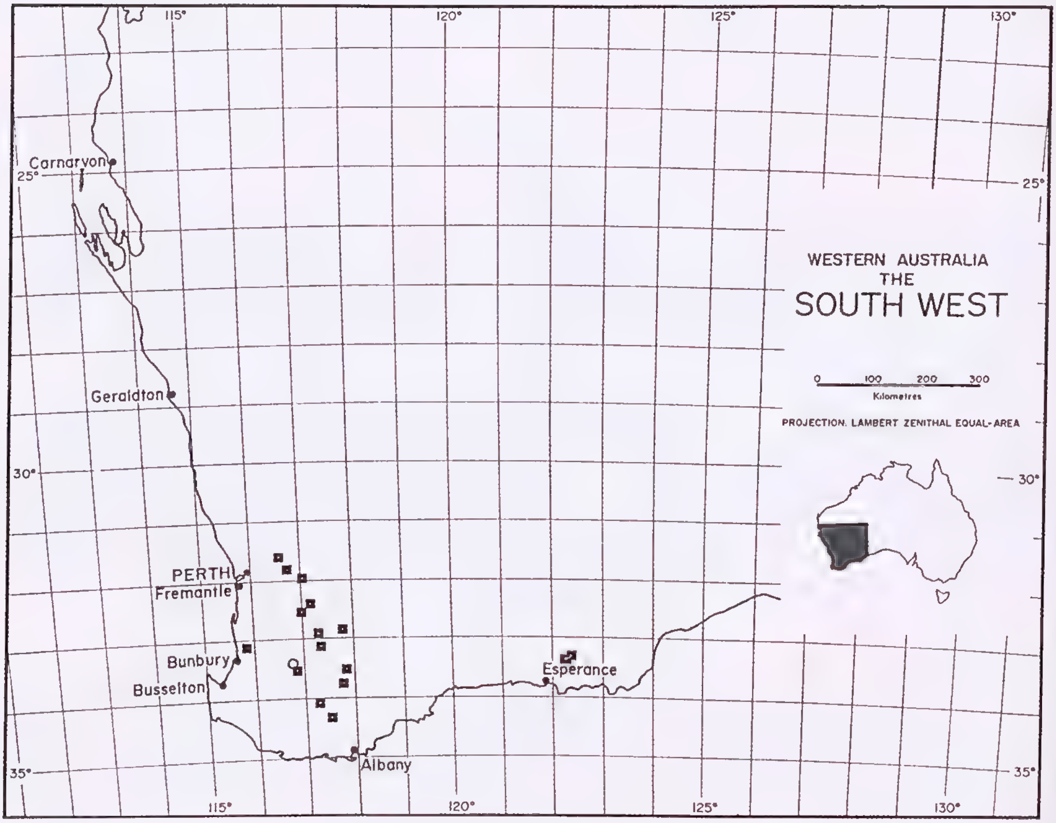

Figure 6. Distribution of exotic species of *Puccinellia* in Western Australia. *P. ciliata* ▣ *P. gigantea* ○

Discussion

Despite the worldwide difficulty of identifying species of *Puccinellia,* most of the specimens in our collection have now been assigned to existing or new species categories. Amongst those collected in Western Australia we now have recorded the native *P. stricta*, and the new species *P. longior* and *P. vassica*, and the introduced *P. ciliata* and *P. gigantea.*

The native species *P. stricta* appears to be reasonably well established and not in need of special consideration for conservation. The new species *P. longior* is represented by only 11 collections. It may be marginally salt-tolerant and thus vulnerable to the increasing salinity in this area and may need to be considered for conservation status.

In stark contrast, *P. vassica* seems to be on the verge of extinction. It had not been collected for 70 years, despite an increased effort in recent years to survey the state's land edges (the SWALE project http://florabase.dec.wa.gov.au/swale/). A SWALE transect was located within a few metres of where *P. vassica* was found in the Bunbury mangrove reserve, yet missed it. It is almost certainly now extinct where first collected in the Vasse-Wonnerup salt marshes near Busselton, because that habitat no longer exists. In the Leschenault reservations there are only small numbers of plants, widely dispersed, and weed invasion is imminent, especially in the mangrove reserve at Bunbury.

Furthermore, *P. vassica* has no apparent competitive defence against invading weeds. While it appears to be a perennial species, the culms die back almost completely each year and only the roots seem to keep a strong and deep hold on its place. It also seems to set few viable seeds as all three sites had only scattered individual plants and nowhere was it in pure stands such as those in which *P. ciliata* is able to establish in similar habitats.

In contrast, the competing perennial grass species in much of its distribution is the native *Sporobolus virginicus* which produces vigorous and enduring stoloniferous growth that can entirely take over suitable habitats. Another competitor is the native sea rush *Juncus kraussii* which keeps a strong hold on ground that it wins by maintaining tall stands of perennially durable tough stems that propagate vegetatively via rhizomes. Amongst the weed competitors, rye grasses (*Lolium* spp.) are prolific seeders and stoloniferous, thus being able to reach in from the non-saline edges into the outer high tide influence zone where *P. vassica* lives.

Amongst the vouchers of material imported into Western Australia by Malcolm and others. I have identified *P. ciliata, P. distans, P. gigantea*, and *P. grossheimiana.* Amongst these it appears that *P. distans* and *P. grossheimiana* have not become naturalized in WA and only one specimen of *P. gigantea* has been collected in the field. It appears that *P. ciliata* has adapted well to WA conditions and is naturalised in the wetter parts of the agricultural region, having spread from initial planting sites to adjacent farmland and roadsides.

Regarding usefulness for reclamation of salt-degraded land *P. ciliata, P. gigantea* and *P. longior* produce the most foliage mass per plant, and *P. ciliata* shows no sign of becoming a nuisance weed. *P. longior* may also be more persistent than the exotic species. In October 2003, Clive Malcolm sent me seven collections of *Puccinellia* from sites that he had planted 30 or 40 years ealier with *P. ciliata* but in only one of these had the latter survived and in all the other 6 sites the specimens were *P. longior*. Landowners wishing to promote native species use could cultivate *P. longior* and develop a seed supply to encourage others to follow suit.

Formal Taxonomy

Species descriptions and an interactive key to the Australian species will soon become available on the FloraBase website: http://florabase.dec.wa.gov.au/ (WA Herbarium 1998–).

Key to *Puccinellia* Species in Western Australia

1. Anther colour rusty brown, 1.1–1.7mm long; ligules 3–5mm long .... **P. longior**

1. Anther colour creamy white, sometimes tinged purple, various lengths; if brownish tinged then <1 mm long and ligules < 3 mm long 2

2. Panicle exserted from flag leaf sheath at anthesis, branches spreading, most being bare in the lower part 3

2. Panicle usually partially enclosed by leaf sheath at anthesis, branches mostly contracted (may spread later), spikelets distributed evenly on branches or crowded near the base 4

3. Glumes subequal, the lower more than half as long as the upper; upper glume 1.9–3.5 mm long; lower glume 1.2–2.3 mm long .... ***P. ciliata**

3. Glumes unequal, the lower being little over half as long as the upper; upper glume 1.2–2 mm long; lower glume 0.8–1.2 mm long .... ***P. gigantea**

4. Spikelets crowded towards base of glabrous panicle branches; lemmas and paleas glabrous in lower half; callus glabrous; ligules 2.5–5 mm long (southwest W.A. marine salt marshes) .... **P. vassica**

4. Spikelets ±evenly distributed along scabridulous panicle branches; lemmas and paleas usually with dorsal hairs in lower half; callus with some hairs; ligules 1–3 mm long (widespread in saline soils in southwest agricultural regions of W.A. and across southern Australasia) .... **P. stricta**

1. Puccinellia stricta (Hook.f.) C.H.Blom, *Acta Horti Gothob.* 5: 89 (1930). – *Glyceria stricta* Hook.f., *Fl. Nov.-Zel.* 1: 304 (1853); *Atropis stricta* (Hook.f.) Hack., *in:* T.F.Cheeseman, *Man. New Zealand Fl.* 914 (1906). *Type:* Launceston, Tas., 24 Dec. 1844, *R.C.Gunn* 1463 (*lecto:* K (high resolution image seen), *fide* H.H. Allan & P. Jansen, *Trans. & Proc. Roy. Soc. New Zealand* 69: 265 (1939); *isolecto:* HO, seen).

Poa syrtica F.Muell., *Trans. & Proc. Victorian Inst. Advancem. Sci.* 45 (1855); *Festuca syrtica* (F.Muell.) F.Muell., *Fragm.* 8: 130 (1873); *Panicularia syrtica* (F.Muell.) Kuntze, *Revis. Gen. Pl.* 2: 782 (1891). *Type:* 'Sandy shores of Lefevre Peninsula [St Vincent's and Spencer's Gulf, S.A.]', 'In grassy pastures at the end of Holdfast Bay' Dec. 16, 1847 (MEL, two sheets, three labels, seen).

Glyceria tenuispica Steud. *Synopsis Plantarum Graminearum* Part 1:285 (1855). *Type: Drummond* collection V no. 347 (*iso:* K, high resolution image seen).

(a) Western Australian (WA) collections character summary:

Root system caespitose; duration annual; *culm* height 85–270 mm; *leaf* blade length 35–135 mm; leaf blade involute, or more or less flat; erect, or flexuose; width 0.5–1.5 mm; ligule length 1–2.3 mm. *Panicle* shape contracted at flowering time (may spread later); panicle length 50–100 mm; panicle branch surface smooth (or almost so), or scabridulous; panicle enclosed by flag leaf, or exserted above flag leaf; number of lower panicle branches per node 3–5; spikelets on lower panicle branches crowded near the base of lateral branches, or evenly spread; spikelets per node (mean of lower two nodes) 9–25. *Spikelets* not overlapping one another on panicle branches, or overlapping one another on panicle branches; minimum peduncle length 0.5–1.5 mm; maximum peduncle length 4–10 mm; maximum branch length 16–36 mm. Spikelet length 4.5–10 mm; number of florets per spikelet 5–10. Lower glume length 1–2 mm; upper glume length 1.5–3 mm; glume tips entire. *Lemma* tip tapering; lemma length 2–3.5 mm; lemma nerves obscure, or prominent; lemma midnerve not extending to the margin; lemma indumentum of sparse hairs near base, or ciliate. *Palea* length 1.9–2.8 mm; scabrous or ciliate in lower half. Callus ciliate. *Anther* length 0.5–0.9 mm; colour creamy white. (Figure 7)

Distribution and phenology. A minor component of halophyte communities on the outer margins of inland saline lakes, river and estuary margins throughout the WA wheatbelt from Utcha Spring north of Hutt Lagoon in the north, to the Fitzgerald River on the south east coast. Also occasionally in salinised pasture and shrubland. Flowers Sept.–Nov. (Figure 3)

(b) Other Australasian (SEANZ) collections character summary:

Root system caespitose; duration annual, or perennial; *culm* height 140–750 mm; *leaf* blade length 50–180 mm; leaf blade involute; erect, or flexuose; width 0.5–1.6 mm; ligule length 0.9–3 mm. *Panicle* shape contracted at flowering time (may spread later); panicle length 65–310 mm; panicle branch surface scabridulous; panicle enclosed by flag leaf; number of lower panicle branches per node 3–9; spikelet distribution on lower panicle branches evenly spread; spikelets per node (mean of lower two nodes) 5–75. *Spikelets* not overlapping one another on panicle branches, or overlapping one another on panicle branches; minimum peduncle length 1–5 mm; maximum peduncle length 5–30 mm; maximum branch length 20–100 mm. Spikelet length 5–10 mm; number of florets per spikelet 4–9. Lower glume length 1–3 mm; upper glume length 2–3.8 mm; glume tips entire. *Lemma* tip tapering; lemma length 2.3–3.7 mm; lemma nerves obscure, or prominent; lemma midnerve not extending to the margin; lemma glabrous, or with sparse hairs near base. *Palea* length 2.1–3.4 mm; scabrous or ciliate in lower half. Callus ciliate. *Anther* length 0.5–0.9 mm; colour creamy white. (Figure 7)

Distribution and phenology. Margins of saline lakes, salt-affected lowlands, marine saltmarsh and estuarine salt flats across southern Australasia. Flowers Sept.–Feb. (Figure 3)

Illustrations. J.P.Jessop & H.R.Toelken (eds), *Fl. S. Australia* 4th edn, 4: 1902, fig. 866A (1986); N.G.Walsh *in* N.G.Walsh & T.J.Entwisle (eds), *Fl. Victoria* 2: 413, fig. 82h–j (1994); W.M.Curtis & D.I.Morris, *Student's Fl. Tasmania* 4B: 205, fig. 60 (1994). Note: the illustration labelled *P. stricta* in Gardner's *Flora of Western Australia* Vol.1, Pt.1, (1952) Plate XXVIIIB is now *P. vassica* A.R.Williams (see this text).

Notes. Recent collections during the wheatbelt survey that focused on salt lake and saline habitats have greatly increased the size of our collection, suggesting that this habitat and species is under-collected in regard to its proportionate representation in PERTH holdings. The common name for this species is 'Australian Saltmarsh Grass'.

(a) Selected specimens examined (all PERTH). WESTERN AUSTRALIA: 17.45 km due SE of Kau Rocks, *M.A. Burgman & C. Layman* MAB 3419, 2 Sep. 1984; R.G. Clarke's property, Lake Grace, *G.H. Burvill s.n.*, 10 Oct. 1946; Gairdner River, Jerramungup, *C.A. Gardner s.n.*, Aug. 1939; 2.5 km NE of the SE of Pinjarrega Lake (Pinjarrega Nature Reserve), *S. Hamilton-Brown* RG 30, 20 Sep.2000; On W side of Grey Road, Utcha Spring Nature Reserve, c. 2.5 km N of Hutt Lagoon, *G.J. Keighery & N. Gibson* 5212, 28 Oct. 1998; Unnamed salt lake SE of Ellen Peak, Stirling Range, *G.J. Keighery* 7035, 28 Oct.1983; Pallinup River, near Greaves Hill, *G.J. Keighery* 8749, 1 Nov. 1986; Northern shore of Lake Dumbleyung, *M.N. Lyons* 2700, 27 Oct. 2000; Eastern shore of Lake Coyrecup, 25 km E of Katanning, *M.N. Lyons* 2702, 12 Oct. 1999; NE shore of Lake Bryde. 18 km SW of Newdegate, *M.N. Lyons* 2705, 11 Oct. 1999; E shore of Lake Ronnerup, Lake King Nature Reserve, *M.N. Lyons* 2707, 9 Oct. 1999; Claypan on W side of Koorda–Wyalkatchem Rd, 1.0 km S of Wyalkatchem North Rd., PERTH 06113273, *M.N. Lyons* 2711, 2 Dec. 1998 and PERTH 06113109, *M.N. Lyons,* 2713, 10 Sep. 2000; Yellilup Swamp, *c.* 37.5 km W of Bremer Bay. , *M.N. Lyons* 2722, 20 Nov. 1999; Yarra Yarra Lake, *c.* 4.5 km S of Three Springs. , *M.N. Lyons* 2725, 2 Oct. 2000; Tardun Christian Brothers College Melaleuca Swamp, *M.N. Lyons* 2726, 26 Sep. 2000; 1.5 km SW of Israelite Hill, *c.* 180 km E of Esperance, *K.R. Newbey* 7982, 9 Nov. 1980; Mouth of Fitzgerald River (Fitzgerald River National Park), *K.R. Newbey* 10997, 21 Oct. 1985; 21 km NE of Scaddan on Lignite Road, *P. van der Moezel,* PGV 474, 12 Sep. 1984; Seagroatt Nature Reserve, *S. Chalwell* SC 17, 14 Oct. 2003.

(b) Selected specimens examined. (non-WA locations): SOUTH AUSTRALIA: Knoxville, eastern suburb of Adelaide, on alkaline soil, 14 Oct. 1928, *J.B. Cleland s.n.* (MEL); Saline swamps near the Grange, about 9km west of Adelaide, 15 Sep. 1962, *D.N. Kraehenbuehl* 645 (AD); Beside Washpool, Sellicks Beach, 15 Oct. 1995, *A.G. Spooner* 15556 (AD). VICTORIA: Wimmera Study Area Sector A, sub-block 3C, 12 Nov. 1986, *A.C. Beauglehole* ACB 86655 (MEL); Wimmera Study Area Sector F, sub-block 28D, 17 Sep. 1984, *A.C. Beauglehole* ACB 84656 (MEL); Clay pans, Lowan, *F.M. Reader s.n.* Nov. 1896 (PERTH). TASMANIA: North East Isle, Kent Group, 10 Dec. 1982, *N.P. Brothers s.n.* (HO); *Sarcocornia – Disphyma* heathland, grazed area of saltmarsh, 13 Nov. 2000, *A.M. Buchanan* 15789 (HO); Brown's River, Kingston, 23 Dec. 1944, *W.M. Curtis s.n.* (HO); Saline mud, edge of Township Lagoon, Tunbridge, 7 Nov. 1978, *D.I. Morris* 7820 (HO); Wasteland next to council refuse disposal area, Township Lagoon, Tunbridge, 9 Nov. 1983, *A. Moscal* 3918 (HO); Glen Morey Saltpan, near Tunbridge, 8 Nov. 1984, *A. Moscal* 8783 (HO). NEW ZEALAND: Saltwater Creek, North Canterbury, 4 Dec. 1979, *E. Edgar & B.A. Matthews s.n.* (CHR); Port Nicholson, North Island, *T. Kirk s.n.* (CHR); Quail Island, eastern end, Banks Peninsula, 27 Dec. 1983, *H.D. Wilson* BP265 (CHR); Saline flats near Heathcote River, Christchurch, 16 Dec. 1957, *A.J. Healy* 57/466 (CHR); At rear of beach, Puponga, N.W. Nelson, Dec. 1978, *A.P. Druce s.n.* (CHR); Saline flats, Saltwater Creek, N. Canterbury, 8 Dec. 1954, *A.J. Healy* 54/538 (CHR); Margin of coastal lagoon, near Ocean Beach, Southland, 28 Feb. 1969, *A.J. Healy* 69/248 (CHR); Coastal rock ledges on steep-sided island close to coastal cliffs of mainland, north of Flea Bay, Banks Peninsula, 4 Dec. 1984, *H.D. Wilson* BP480 (CHR).

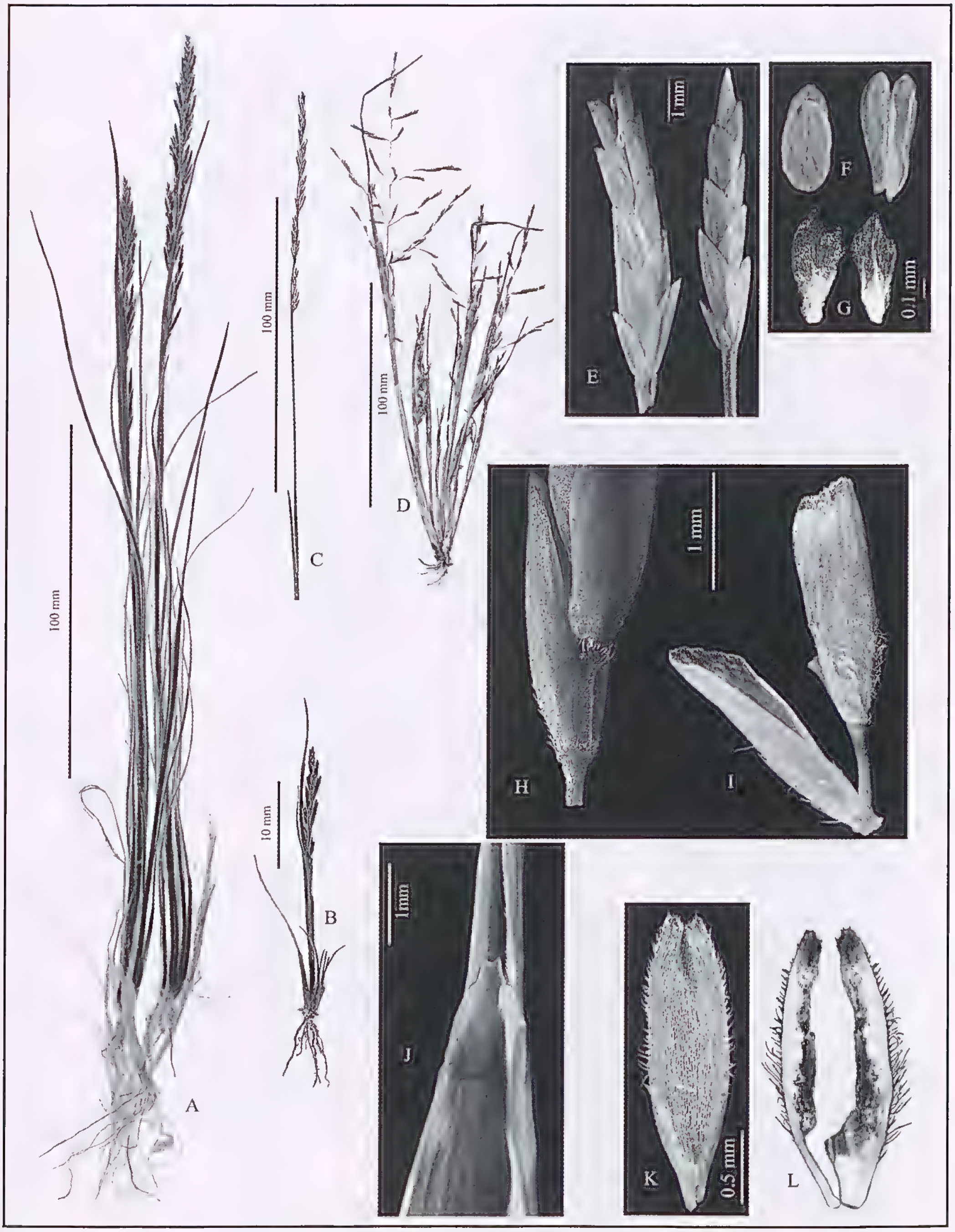

Figure 7. *Puccinellia stricta* in Western Australia. A – normal plant with contracted panicle; B – dwarf plant; C – exserted panicle with short branches and few spikelets; D – plant with expanded panicle; E – spikelets; F – anthers; G – lodicules; H – normal lemmas with few small hairs near base and on callus; I – ciliate lemmas; J – ligule; K – normal palea with keel hairs; L – palea split and flattened to show lower extent of keel hairs. Digital images from *K.R. Newbey* 10997 (A, E–H, J–K); *M.N. Lyons* 2701 (B); *G.J. Keighery & N. Gibson* 5212 (C); *M.N. Lyons* 2726 (D, I, L) (PERTH).

2. Puccinellia longior A.R.Williams, *sp. nov.*

Affinis *P. stricta* sed plantae saepe ampliatas; ligula 3–5 mm longam; antherae lineares, ferrugineas, 1.1–1.7 mm longas; distributio restrictam lacusides salini paludes margineum et campi salini continentalis inferior austro-occidentalis Australia Occidentalis.

Typus: Lake on S side of Warren Rd, 7.5 km SW on Warren Rd of intersection with Coomelberrup Rd, *c.* 16.5 km NE of Katanning, 33° 36' 35.400" S, 117° 42' 47.000" E, 24 October 1999, *M.N. Lyons* 2710 (*holo:* PERTH 06113168; *iso:* AD, CANB).

Root system caespitose; duration annual, or perennial; *culm* height 250–750 mm; *leaf* blade length 75–350 mm; leaf blade involute, or more or less flat; erect, or flexuose; width 0.5–1.5 mm; ligule length 3.3–4.8 mm. *Panicle* shape contracted at flowering time (may spread later); panicle length 85–290 mm; panicle branch surface scabridulous; panicle enclosed by flag leaf; number of lower panicle branches per node 2–5; spikelet distribution on lower panicle branches evenly spread; spikelets per node (mean of lower two nodes) 8–137. *Spikelets* not overlapping one another on panicle branches, or overlapping one another on panicle branches; minimum peduncle length 0.5–6 mm; maximum peduncle length 3–37 mm; maximum branch length 11–120 mm. Spikelet length 4–10 mm; number of florets per spikelet 3–9. Lower glume length 1.2–2.2 mm; upper glume length 2–3.3 mm; glume tips entire. *Lemma* tip tapering; lemma length 2.4–3.7 mm; lemma nerves obscure; lemma midnerve not extending to the margin; lemma indumentum glabrous, or sparse hairs near base. *Palea* length 2.3–3.4 mm; indumentum scabrous or ciliate in lower half. Callus hairs ciliate. *Anther* length 1.1–1.7 mm; colour rusty brown. (Figure 8)

Distribution and phenology. Native, WA, SA. Recorded in WA only from the outer margins of inland saline lakes and salt-affected areas within the southern wheatbelt, on the transition from rejuvenated drainage on the coast to ancient drainage inland. The single record from South Australia is from the outer margins of a salt lake in the south east (the wetter area) of the state. Its presence could perhaps be anticipated in south-western Victoria. Flowers Sept.–Nov. (Figures 2,3)

Specimens examined (all PERTH). WESTERN AUSTRALIA: 23 km NW of Mt Barker, Wamballup Nature Reserve, *A.R. Annels* ARA 3786, 22 Sep. 1993; N shore of Lake Dumbleyung, *M.N. Lyons* 2706, 26 Oct. 2000; Twonkwilling Pool, on Police Pools Rd 4.5 km SE of Katanning, *M.N. Lyons* 2717, 12 Sep. 1999; Little White Lake, *c.* 19 km ENE of Highbury, Arthur River Nature Reserve, *M.N. Lyons* 2708, 9 Nov. 2000; Parkeyearing Lake, 5 km S of Wagin, *M.N. Lyons* 2714, 26 Oct. 2000; Yoting Town Reserve, 18.5 km E Quairading, *B.G. Muir* 219, 6 Sep. 1977; Aldersyde, R. Sudholz property, Brookton, *C.V. Malcolm* CVM 82, 28 Sep. 2003; Quairading, Ivan Lee property 'Bulyee', *C.V. Malcolm* CVM 83, 30 Sep. 2003; Mt Kokeby, T. Ridgeway property, *C.V. Malcolm* CVM 84, 29 Sep. 2003; Quairading, Hinkley property, *C.V. Malcolm* CVM 92, 30 Sep. 2003; SOUTH AUSTRALIA: Gum Lagoon Conservation Park, 36° 17' 13" S, 140° 11' 18" E, *R.J. Davies* GL1255, 16 Nov. 1996 (AD).

Etymology. The epithet *longior* is derived from Latin and refers to the long anthers and long ligules.

Affinities. P. longior appears to be most closely related to *P. stricta*, but the long rusty colored anthers are distinctive. I considered the possibility of it being a hybrid with *P. ciliata*, which grows across a similar range, but the anthers on the latter are white, often with a purple tinge, and are quite distinct. One specimen of *P. stricta* from Island Bay in New Zealand (CHR25440, *A.J. Healy s.n.*, 9 Nov. 1940) had small (0.6 mm) rusty colored but somewhat immature anthers. This suggested to me that

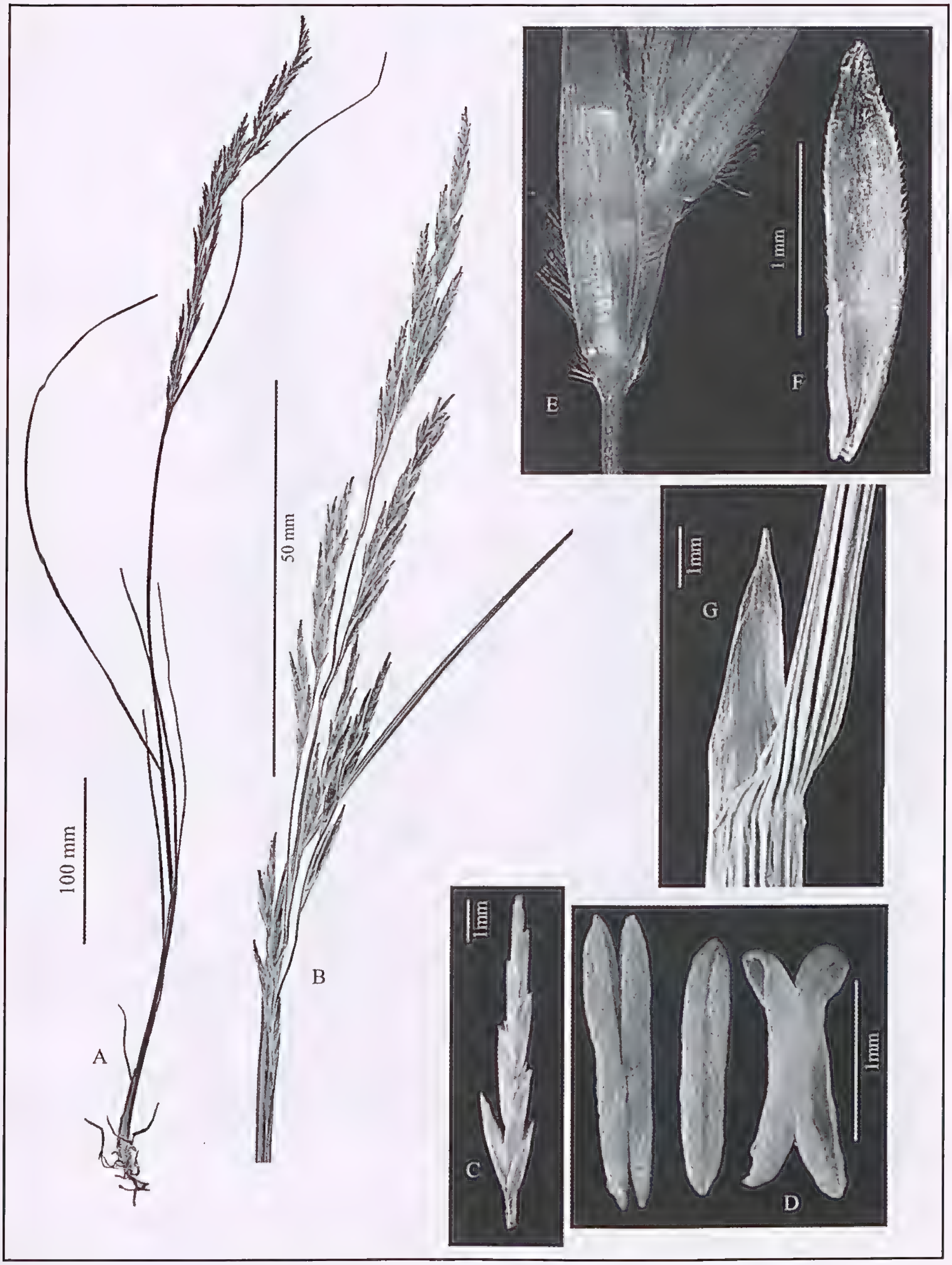

Figure 8. *Puccinellia longior*. A – single flowering culm; B – panicle; C – spikelet; D – anthers; E – lemmas with callus and rachilla segment; F – palea; G – ligule. Digital images from *M.N. Lyons* 2710 (A, C, G); *M.N. Lyons* 2714 (B); *M.N. Lyons* 2706 (D, E–F) (PERTH).

perhaps this character was in the ancestral gene pool of the native rather than the exotic species and had been retained until it became expressed here in *P. longior.* All but one of our collections carried no fruiting-stage spikelets, but that one specimen (*B.G. Muir* 219) had two old panicle branches on it. Amongst the few remaining spikelet fragments, I found two mature seeds (one an empty, insect-eaten half shell, and the other a fungus-riddled whole that disintegrated when I touched it), so the taxon is fertile, which eliminates the sterile-hybrid (but not the fertile-hybrid) possibility.

3. **Puccinellia vassica** A.R.Williams, *sp. nov.*

Affinis *P. stricta* var. *stricta* sed spiculae aggregata in pedunculi brevis glabri, palea pro parte maxima glabra, et habito palus salsa ora austro-occidentali Australia Occidentalis differt.

Typus: coastal salt marsh, Leschenault Inlet, 16 November 2005, *A.R. Williams* 878 (*holo:* PERTH 07576021, *iso:* AD, CANB).

Illustration. C.A.Gardner, *Flora of Western Australia* Vol.1, Pt.1. Plate XXVIIIB (1952) as *P. stricta.*

Root system caespitose; duration annual, or perennial; *culm* height 410–545 mm; *leaf* blade length 120–215 mm; leaf blade involute; erect; width 0.8–2.5 mm; ligule length 2.5–5 mm. *Panicle* shape contracted at flowering time (may spread later); panicle length 150–185 mm; panicle branch surface smooth (or almost so); panicle enclosed by flag leaf, or exserted above flag leaf; number of lower panicle branches per node 2–15; spikelet distribution on lower panicle branches crowded near the base of lateral branches; spikelets per node (mean of lower two nodes) 20–75. *Spikelets* crowded together near the nodes; minimum peduncle length 1–2 mm; maximum peduncle length 3–17 mm; maximum branch length 10–70 mm. Spikelet length 6.5–10.5 mm; number of florets per spikelet 5–10. Lower glume length 1.9–2.8 mm; upper glume length 3.1–4 mm; glume tips entire. *Lemma* tip tapering; lemma length 3.1–4.5 mm; lemma nerves obscure; lemma midnerve not extending to the margin; lemma indumentum glabrous. *Palea* length 2.9–3.4 mm; indumentum glabrous in lower half. Callus hairs glabrous. *Anther* length 0.8–1 mm; colour creamy white. Figure 9

Specimens examined. WESTERN AUSTRALIA: Busselton, 1870, *A. & E. Pries s.n.* (MEL); Busselton,14 Nov. 1936, *C.A. Gardner s.n.* (PERTH); *Drummond* 219 (MEL); *Drummond s.n.* (MEL 2139536); *Drummond s.n.* (MEL 2139537); *Drummond s.n.* (MEL 2139538); Leschenault Inlet, 5 Nov. 2005, *G.J. & B.J. Keighery* 962; Bunbury, 16 Nov. 2005, *A.R. Williams* 875 (PERTH); Leschenault Inlet, 16 Nov. 2005, *A.R. Williams* 880 (PERTH).

Distribution and phenology. Native, W.A. Collected recently only from the outer margins of coastal saltmarsh in the Leschenault Inlet; collected in 1870 and 1936 from the Vasse-Wonnerup estuary near Busselton but the habitat has since been destroyed by the installation of floodgates to reduce inflow of seawater. Flowers Sept.–Nov. (Figure 3)

Conservation status. DEC Conservation Codes for Western Australian Flora: Priority One.

Etymology. The species epithet alludes to the region of first collection, the Vasse region surrounding the town of Busselton. The Vasse River was named after a French sailor who drowned there in the 18th century. The common name of this species is 'Busselton Salt Grass'. Also previously known by the phrase name *Puccinellia* sp. Busselton (*C.A. Gardner s.n.* PERTH 00477664).

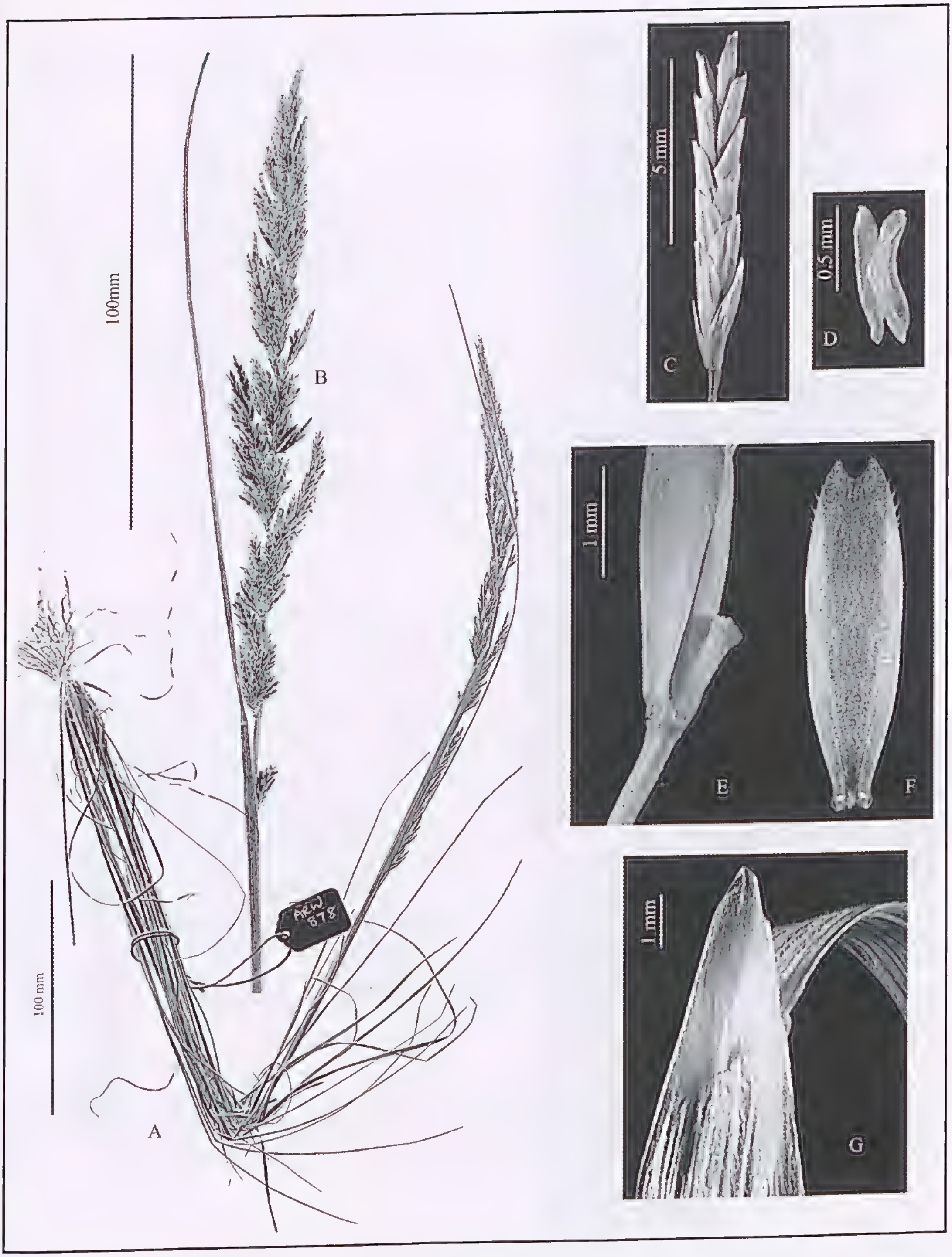

Figure 9. *Puccinellia vassica*. A – whole plant; B – panicle with lots of spikelets crowded onto short branches; C – spikelet; D – anther; E – glabrous lemma and callus attached to rachilla segment; F – palea with largely glabrous margins; G – ligule. Digital images from *A.R. Williams* 878 (A, C–D, G) and Busselton, 14 Nov. 1936, *C.A. Gardner s.n.* (B, E–F) (PERTH).

4. ***Puccinellia ciliata** Bor, *Notes Roy. Bot. Gard. Edinburgh* 28: 299–300 (1968). *Type:* Cultivated at CSIRO field station, Kojonup, W. Australia from seed collected at Kahic, 12 km from Menemen, N of Izmir, near the sea, Bi Izmir, Turkey, 1951, *Miles & Donald s.n.* (*holo:* E *n.v.*; *iso:* K *n.v.*, PERTH, *fide* Tan, K., *Flora of Turkey*, 9:508, 1985).

Root system caespitose; duration perennial; *culm* height 340–700 mm; *leaf* blade length 70–135 mm; leaf blade involute, or more or less flat; erect; width 0.5–1 mm; ligule length 1–6 mm. *Panicle* shape spreading at flowering time, or spreading, some branches deflexed; panicle length 120–175 mm; panicle branch surface scabridulous; panicle exserted above flag leaf; number of lower panicle branches per node 2–10; spikelet distribution on lower panicle branches evenly spread, or mainly at the ends of long bare peduncles; spikelets per node (mean of lower two nodes) 16–70. *Spikelets* not overlapping one another on panicle branches, or overlapping one another on panicle branches; minimum peduncle length 1–8 mm; maximum peduncle length 9–22 mm; maximum branch length 48–65 mm. Spikelet length 7–12 mm; number of florets per spikelet 5–11. Lower glume length 1.2–2 mm; upper glume length 2–3.5 mm; glume tips entire. *Lemma* tip tapering; lemma length 2.5–3.5 mm; lemma nerves prominent; lemma midnerve not extending to the margin; lemma indumentum glabrous, or sparse hairs near base, or ciliate. *Palea* length 2.6–2.9 mm; indumentum scabrous or ciliate in lower half. Callus hairs ciliate. *Anther* length 1.3–2 mm; colour creamy white, or creamy white with purple tinge. (Figure 10)

Specimens examined (all PERTH). WESTERN AUSTRALIA: Dattening, 5 Nov. 1997, *G.J. Keighery* 15069; NW shore Towerrinning Lake, 3 km NW of Moodiarup, 16 Nov. 2000, *M.N. Lyons* 2704; Boomall Brook, Kauring townsite, York, 13 Sep. 1999, *C. Howell* 474; Cultivated: CSIRO Field Station, Kojonup, 26 Oct. 1966, *A. Rogers s.n.*; Boomall Brook, Kauring townsite, York, 13 Sep. 1999, *C. Howell* 471; Cultivated: Department of Agriculture Glasshouse, 4 Nov. 1964, *C.V. Malcolm s.n.*; Wittenoom Hills Rd at deep culvert N of Plowmans Rd, 2 June 1999, *C.D. Turley* 7/699; Harvey, Oct. 1970, *J. Clarke s.n.*; Broomehill, Aug. 1970, *M. Coffey s.n.*; Crawley, 1971, *A.J. Paganon* 24; Wooroloo near El Caballo Blanco, E of Bodguero Way, 11 Dec. 1998, *U. Bell* 57; E side Toolibin Lake, 18 Nov. 1998, *A. Baxter & T. Macfarlane* AB 40; 3.1 km SE of Spencers Brook Rd on Mokine Rd, *c.* 13 km SW of Northam, 2 Nov. 1996, *B.J. Lepschi & T.R. Lally* BJL 3158. TURKEY: Turkey – 10 km from junction with Ankara Rd, 19 July 1967, *C.V. Malcolm* 161; Turkey – 41 km S of Igdir on road to Agri, 25 July 1967, *C.V. Malcolm* 176; 10 km from junction with Ankara Rd on Aksanay Rd, 19 July 1967, *C.V. Malcolm* 161(3); Turkey – 11 km W of Van on road to Tatvan, 28 July 1967, *C.V. Malcolm* 184; Turkey – 31 km S of Agri, 26 July 1967, *C.V. Malcolm* 181; 41 km S of Iugdir on road to Augri, Turkey, 25 Sep. 1967, *C.V. Malcolm* 177; 41 km S of Igdir on road to Agri, Turkey, 25 Sep. 1967, *C.V. Malcolm* 178.

Distribution and phenology. Introduced; native to Turkey. WA, SA, NSW, Victoria. Introduced into WA for the purpose of reclaiming salt-affected pasture land; now spread into adjoining road verges and saline lakes. Flowers Apr.–Nov. (Figure 6)

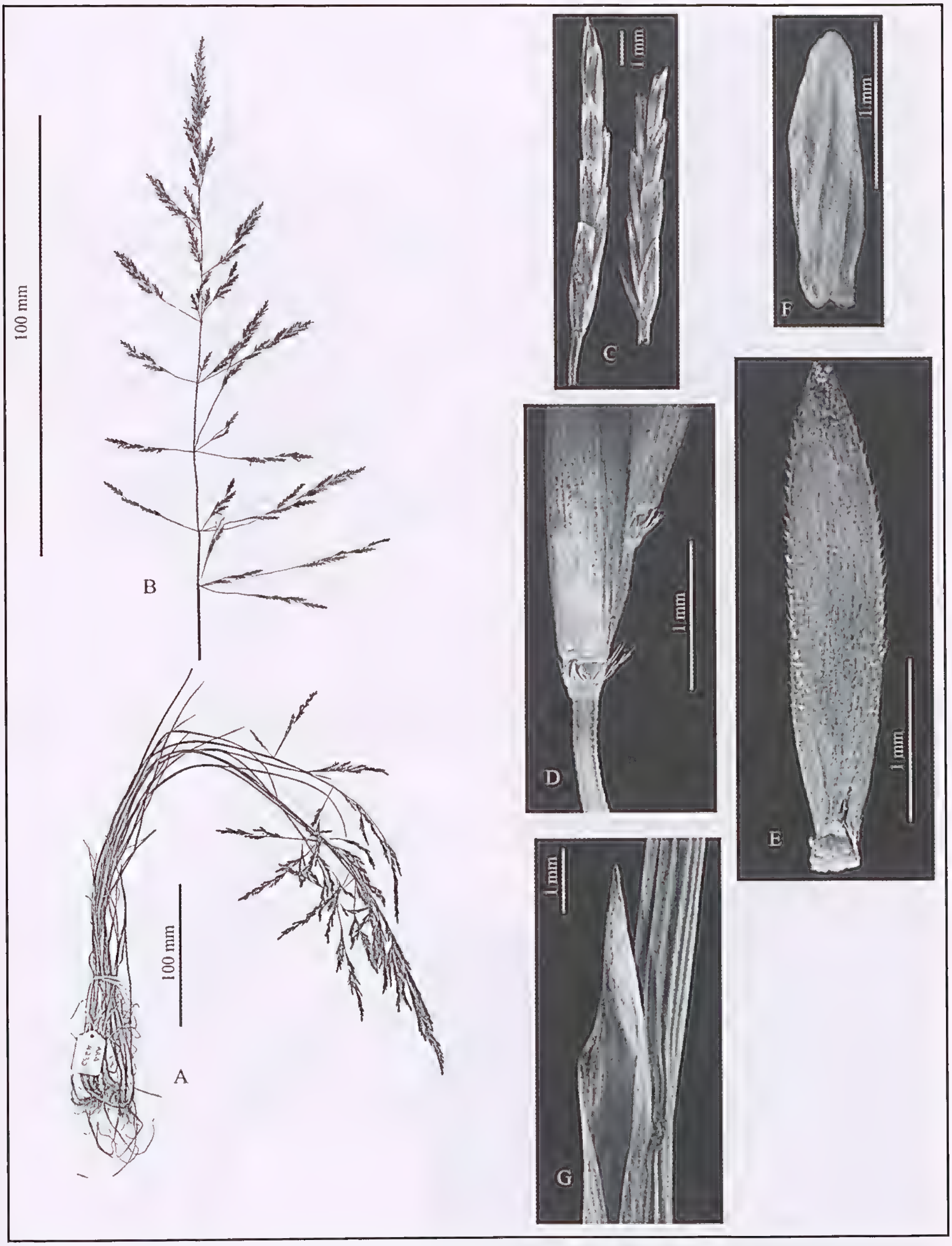

Figure 10. *Puccinellia ciliata.* A – tussock; B – panicle; C – spikelet; D – lemmas and rachilla segment; E – palea; F – anther; G – ligule. Digital images from *A.R. Annels* ARA 4232 (PERTH).

5. *Puccinellia gigantea (Grossh.) Grossh., *Fl. Kavk.* 1:114(1928) – *A. gigantea* Grossh. *in Monit. Jard. Bot. Tiflis* 46:35, t. 2 (1919). *Type:* Baku, distr. Lenkoran, Kumbashi, in pratis, 17 May 1916, A. Grossheim (*holo:* LE, *iso:* TGM).

Illustration: *Fl. URSS* 2: t. 37 f. 24 (1934), as *A. gigantea.*

Root system caespitose; duration perennial; *culm* height 440–800 mm; *leaf* blade length 65–160 mm; leaf blade involute; erect; width 0.8–1 mm; ligule length 3–4 mm. *Panicle* shape spreading at flowering time, or spreading, some branches deflexed; panicle length 150–190 mm; panicle branch surface smooth (or almost so), or scabridulous; panicle exserted above flag leaf; number of lower panicle branches per node 5–6; spikelet distribution on lower panicle branches evenly spread, or mainly at the ends of long bare peduncles; spikelets per node (mean of lower two nodes) 15–55. *Spikelets* not overlapping one another on panicle branches, or overlapping one another on panicle branches; minimum peduncle length 1–2 mm; maximum peduncle length 15–25 mm; maximum branch length 35–80 mm. Spikelet length 7–10 mm; number of florets per spikelet 6–11. Lower glume length 0.8–1.2 mm; upper glume length 1.5–2 mm; glume tips entire. *Lemma* tip tapering; lemma length 2.2–2.8 mm; lemma nerves prominent; lemma midnerve not extending to the margin; lemma indumentum glabrous, or sparse hairs near base. *Palea* length 2.5–2.9 mm; indumentum scabrous or ciliate in lower half. Callus hairs ciliate. *Anther* length 1.2–1.6 mm; colour creamy white, or creamy white with purple tinge. (Figure 11)

Specimens examined (all PERTH). WESTERN AUSTRALIA: NW shore of Towerrining Lake, 3 km NW of Moodiarup., 16 Nov. 2000, *M.N. Lyons* 2703. TURKEY: E of Kendirlik, 1 km by river, 11 July 1967, *C.V. Malcolm* 147.

Distribution and phenology. Introduced; native to Middle East and central Asia. Introduced into WA for the purpose of reclaiming salt-affected pasture land. Only one naturalized record from lower wheatbelt WA. Flowers Nov. (Figure 6)

Puccinellia perlaxa (N.G. Walsh) N.G.Walsh & A.R. Williams, *stat. nov.*

Puccinellia stricta var. *perlaxa* Walsh, N.G., *Muelleria* 7:382–384; Fig.1g,h,i p.380 (1991). *Type:* Victoria, Altona, 3 km SE of Laverton, 4 km SSW of Altona P.O., 25 Nov. 1977, *T.B. Muir* 5659 (MEL).

Notes. This species does not occur in WA. The multivariate analysis of *P. stricta* specimens from across Australasia reported in this paper included more panicle characters than had been used in previous studies and this revealed the taxon to be quite distinct from all other *P. stricta* collections. In consultation with Neville Walsh we have here elevated it to species rank.

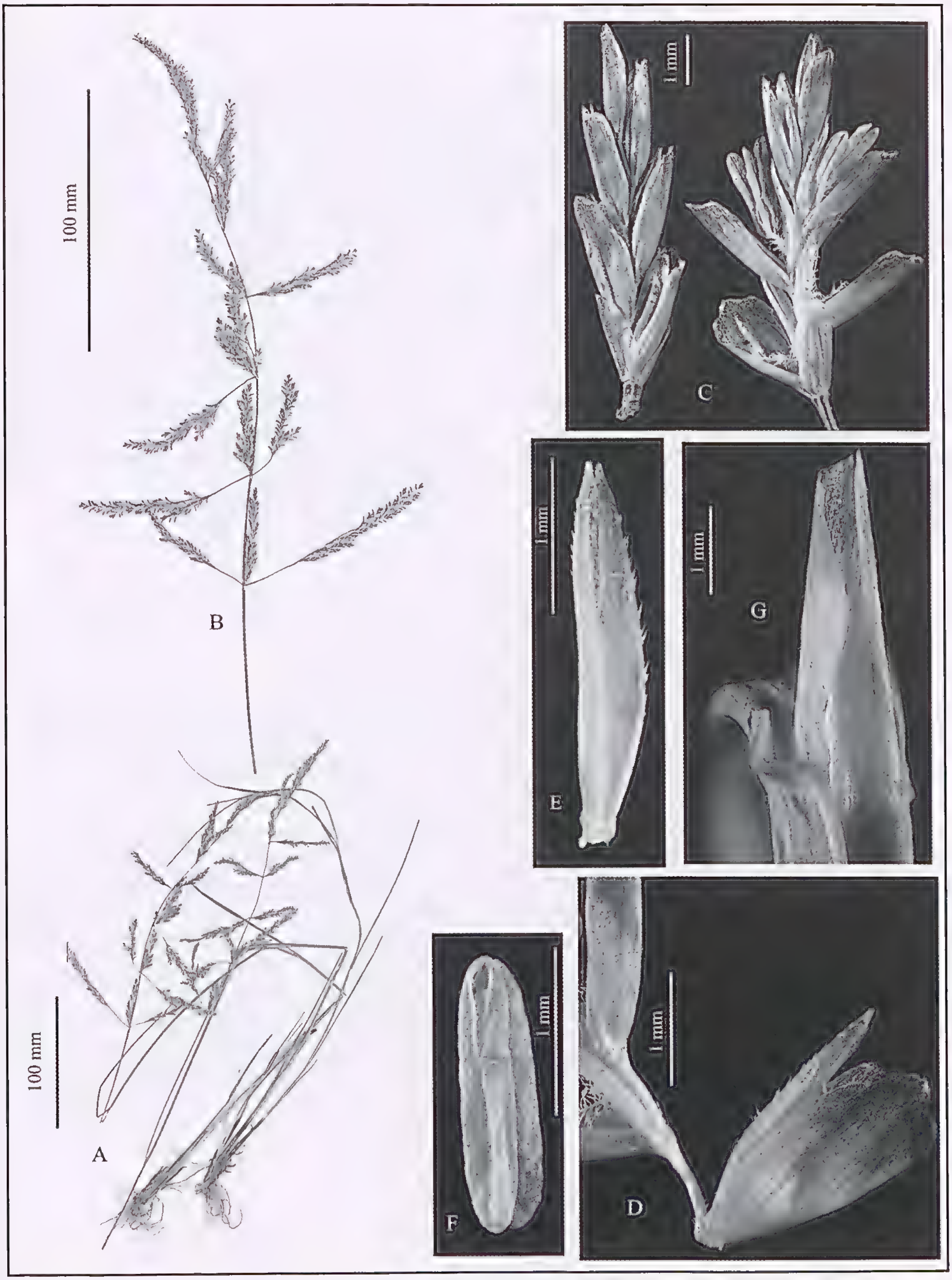

Figure 11. *Puccinellia gigantea*. A – two whole plants; B – panicle; C – spikelets; D – lemmas with rachilla segment; E – palea; F – anther; G – ligule. Digital images from *M.N. Lyons* 2703 (PERTH).

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SHORT COMMUNICATIONS

Occurrence and status of *Pentapogon quadrifidus* (Poaceae) in Western Australia

Pentapogon R.Br. (Poaceae) is a genus endemic to Australia, currently considered monospecific. The species *P. quadrifidus* (Labill.) Baill. (Fiveawn Speargrass) is native in South Australia (Jessop *et al.* 2006), New South Wales (Jacobs & McClay 1993), Victoria (Walsh 1994) and Tasmania (Morris 1991). A varietal taxon was described by Bentham (1878) from Tasmania although not again recognised until Morris (1990) confirmed its validity and corrected its nomenclature.

Pentapogon has not been considered to occur in Western Australia except in reference to the original generic position for the species now known as *Deyeuxia drummondii* (Steud.) J. Vickery (Vickery 1940; Gardner 1952).

In 1995 A.R. Annels and R.W. Hearn collected grasses among other flora from a location near Rocky Gully, Western Australia, during an investigation of the site for the occurrence of threatened flora. One of the grasses was identified as *Pentapogon quadrifidus*, the first definite record of the species from Western Australia. Subsequent visits to the location confirmed its continuing presence.

The Rocky Gully site is a low-lying and winter-wet flat with low shrubs and open herb fields on sandy clay soils over laterite, drying out in summer. The surrounding vegetation is Jarrah (*Eucalyptus marginata* Sm.) and Marri (*Corymbia calophylla* (Lindl.) K.D.Hill & L.A.S.Johnson) forest. This habitat is consistent with at least some habitats in which it grows in eastern Australia. However the site shows evidence of past disturbance including possible clearing and grazing seeing as there is an old fence, and there is also some usage of a vehicle track passing through the area. This disturbance and the single known Western Australian locality left open the possibility that *Pentapogon quadrifidus* is not native there, that it may for example have been introduced in animal fodder. Further survey was undertaken to see whether a better view of its status could be formed.

At the original site the topography was relatively flat with unclear drainage lines so that it was difficult to relate the hydrographic zonation and vegetation associations to the occurrence of *Pentapogon quadrifidus*. The wetland was examined more extensively and a drainage line was found where the hydrographic and vegetation zonation were clearer. The centre of the wetland was a woodland of *Eucalyptus rudis* Endl. and *Melaleuca preissiana* Schauer with tall shrubs of *Melaleuca densa* R.Br. and *Viminaria juncea* (Schrad. & J.C.Wendl.) Hoffmanns., and there was a transition to a low shrubland dominated by *Hypocalymma angustifolium* (Endl.) Schauer, *Astartea* sp. and *Pericalymma* sp. *Pentapogon quadrifidus* was found in a narrow zone at the edge of the winter wet area where this low shrubland gradually changed to eucalypt forest dominated by Jarrah and Marri. The *P. quadrifidus* plants, which are sparsely tufted perennials, grew in the open and in the shelter of shrubs through which the flowering culms project.

The concept of the habitat preferences of *Pentapogon quadrifidus* thus acquired was used in a wider survey of selected wetlands in the area that were considered to be possible sites for the species. Some of these sites proved to have different vegetation or physical characteristics from the original site or were degraded and did not have the target species, although at least one site looked suitable but also lacked *P. quadrifidus*. *Pentapogon quadrifidus* was found at one other site that looked suitable, the low-lying flats beside the Frankland River where it crosses Muir Highway. At this location it was scattered sparsely over a wide zone, the gradient being more gradual than the water course at Rocky

Gully but resembling the original collection point in associated species and soil. The associated vegetation consisted of an open woodland of *Eucalyptus rudis* and *Corymbia calophylla* with scattered tall shrubs of *Melaleuca preissiana, Allocasuarina humilis* (Otto & F.Dietr.) L.A.S.Johnson, *Hakea prostrata* R.Br., *H. varia* R.Br. *and Xanthorrhoea preissii* Endl. and an open sedge ground layer. The vegetation at this second location appeared virtually undisturbed by human activity.

Subsequently a third population of *Pentapogon quadrifidus* was discovered by the authors while engaged in field work for other purposes. At Wamballup Nature Reserve NE of Mount Barker it grew in low-lying flats adjacent to a severely salt-affected water course. This habitat was more open and the vegetation sparser and with fewer shrubs than at the other two sites. It grew with several other native perennial grasses and exotic annual grasses, among other plants. It seems likely that further populations may be found, although in a search at a very promising site at Gordon Hall *P. quadrifidus* was not found even though the vegetation was in good condition including eight native grass species.

Pentapogon quadrifidus is thus known from three separate locations where it grows in consistent habitats among native vegetation in good condition. At each site it is scattered through the vegetation at varying densities but never dominating. From this pattern we concluded that the species is most likely to be native to Western Australia. We assume that it has been overlooked because it occurs in only a few sites, is inconspicuous, and superficially resembles *Austrodanthonia* species, especially *A. setacea*. Because of its apparently localised distribution it had a Priority 1 conservation rating for Western Australia in Atkins (2006). It is now considered to carry a Conservation Code for Western Australian Flora: Priority 2 following the discovery of the population in a nature reserve. This survey has achieved some of the management requirements listed for this species by Hearn *et al.* (2006).

Pentapogon has the following key features: perennial, ligule an unfringed membrane, inflorescence paniculate, spikelets 1-flowered, without incomplete florets, at least sometimes with a rachilla extension, the lemma firmer than the glumes and becoming moderately hardened at maturity, 5-awned, the central awn longest and with twisted column, geniculate, attached dorsally, the lateral awns not twisted or geniculate, comprising a scabrid bristle terminating the lateral lobes and the inner two longer than the outer two. Two of these features are not generally recognised for *Pentapogon.* Firstly, the central awn is variously described as dorsal (e.g. Watson & Dallwitz 1992; 1992 onwards), from the apical sinus, i.e. terminal (Jacobs & McClay 1993) or as either (Bentham 1878). We observed it to be dorsal and subterminal, being inserted on the back of the lemma a short distance (*c.* 0.3 mm) below the apex of the lemma body which in this case is represented by the base of the sinus between the two innermost lateral lobes. This can only be seen with careful study and avoidance of splitting the lemma. Secondly, we also observed in WA material that there can be a prolongation of the rachilla above the floret, although it is very short, *c.* 0.15 mm, and obscure because of being tucked under the edge of the lemma so that it only became visible upon probing. This feature has been reported as absent in *Pentapogon* (Watson & Dallwitz 1992, 1992 onwards; Sharp & Simon 2002) and further checking will be required to determine whether it is always present. Rachilla prolongation is of importance because of its bearing on considerations of the relationships of *Pentapogon* and as evidence that *P. quadrifidus* evolved from a multi-floreted ancestor.

The South Western Australian native genera most similar to *Pentapogon* in technical details include *Deyeuxia, Dichelachne* and *Echinopogon* but none of these have more than two lateral lobes or bristles on the lemma. The general appearance is most like *Austrodanthonia* in the field and *P. quadrifidus* may in the past have been overlooked because of this resemblance. Although differing from *Austrodanthonia* in important respects including the membranous ligule and the 1-flowered spikelets, the spikelets of *P. quadrifidus* nevertheless may superficially give the impression of being multiflowered because of the 5 awns which protrude from the spikelet in a bunched manner.

The Western Australian plants are considered to belong to *Pentapogon quadrifidus* var. *quadrifidus*. The type variety has spikelets with glumes measuring 5–14 mm long (Walsh 1994, Jessop *et al.* 2006), the Western Australian material measuring *c.* 8 mm. *P. quadrifidus* var. *parviflorus* (Benth.) D.I. Morris (Bentham 1878, Morris 1990), limited to Tasmania, has smaller spikelets with glumes less than 4 mm long. All other observed features of the W.A. plants are consistent with var. *quadrifidus* so there is no indication that it is an undescribed Western Australian endemic taxon.

Specimens examined. Western Australia: Muir Highway, 3.5 km E of junction of Frankland Rd in Rocky Gully townsite, 34° 31' 15.000" S, 117° 02' 40.000" E (GDA94), 23 Nov. 1995, *A.R. Annels & R. Hearn* ARA 5585 (PERTH); same location, *T.D. Macfarlane* 3767 (PERTH); same location, *T.D. Macfarlane & R.W. Hearn* TDM 3771 (PERTH); Frankland River near Muir Highway crossing, 14 Dec. 2004, *T.D. Macfarlane & R.W. Hearn* TDM 3777 (PERTH); Wamballup Nature Reserve, *c.* 23 km NW of Mt Barker, 1.5 km along Wamballup Road from Boyup–Cranbrook Rd, 30 Oct. 2006, *T.D. Macfarlane & R.W. Hearn* TDM 3909 (PERTH).

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T.D. Macfarlane[1] and R.W. Hearn[2]

[1]Western Australian Herbarium, Science Division and [2]Warren Region,
Department of Environment and Conservation,
Locked Bag 2, Manjimup, Western Australia 6258

Agrostis castellana (Poaceae) mis-identified as *A. capillaris* var. *aristata* in Western Australia

In the process of assisting with the updating of *Western Weeds: a Guide to the Weeds of Western Australia* (Hussey & Keighery 1997) we became aware that Batson (1998) had identified *Agrostis castellana* Bois. et Reuter as the dominant species in 'bent grass' pastures in South-eastern Australia, which had previously been reported as being dominated by *A. capillaris* L. (syn. *A. tenuis* Sibth.).

In the Census of Western Australian Plants – FloraBase (Western Australian Herbarium 2006), *A. capillaris* var. *capillaris* and *A. capillaris* var. *aristata* (Parn.) Druce were listed as occurring in Western Australia, and under the same names were treated by Hussey *et al.* (1997) and described and keyed out by Wheeler *et al.* (2002). Upon examination, the PERTH collections of *A. capillaris* var. *aristata* were all found to fit the description of *A. castellana* as given in Batson (1998).

The Census has therefore been updated and now lists *A. capillaris* and *A. castellana* as introduced weeds in Western Australia (Western Australian Herbarium 2006).

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T.D. Macfarlane and A.R. Williams

Western Australian Herbarium
Department of Environment and Conservation
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983

Recombinations in Western Australian Orchidaceae 1

In recent years many genera of Australian Orchidaceae have been revised (see eg. Clements and Jones 2002; Jones 2002; Jones *et al.* 2001, 2002; Jones & Clements 2002a, 2002b, 2003; Hopper and Brown 2000, 2004; Szlachetko 2001, 2003), resulting in substantial instability due to the splitting of well-established genera into a large number of smaller segregates. Among Western Australian genera, *Caladenia*, *Corybas*, *Dendrobium*, *Microtis, Prasophyllum* and *Pterostylis* have been revised and may be subject to further revision. Accepting all proposed nomenclatural changes would result in generic reassignments for 152 species, amounting to 39% of orchid species currently accepted in the Census of Western Australian Plants (Western Australian Herbarium 1998–), and the creation of 20 new genera.

The most problematic genera are *Caladenia* and *Pterostylis*, which have recently been segregated into seven and 16 genera respectively (Clements and Jones 2002; Jones 2002; Jones *et al.* 2001a, 2002; Jones and Clements 2002a, 2002b, 2003; Szlachetko 2001, 2003). Arguments for the segregation of these genera have been made in the above cited papers. Conversely, arguments for retention of the whole of *Pterostylis s. lat.* and the major portion of *Caladenia s. lat.* have been made by Hopper and Brown (2000, 2004) and Hopper (2004). Morphological and molecular analyses provide clear evidence that the traditional genera in these instances are monophyletic (after some minor reassignments in the case of *Caladenia*; see Hopper and Brown 2000, 2004; Jones and Clements 2002b; Kores *et al.* 1997, 2000, 2001), the segregate genera being well-supported clades within the monophyletic main groups.

In other cases, such as the separation of *Hydrorchis* from *Microtis s. lat* by Jones *et al.* (2002), the decision to segregate appears to be based on relatively minor morphological differences with no supporting molecular data. Current information provides no reason to regard *Microtis s. lat.* as non-monophyletic.

The position accepted by the Australian Plant Census (APC) working groups and by the Council of Heads of Australasian Herbaria with respect to the rare and threatened orchid taxa covered so far for the APC (Australian Plant Census 2007; Entwisle and Weston 2005) is to retain the traditional genera and to recognise well-supported clades within them at infrageneric rank or as informal groupings. This position is provisionally adopted at PERTH, until compelling evidence for the need to segregate is presented.

Two new species from Western Australia were recently described under the segregate genera *Hydrorchis* (Jones and Brockman 2005) (= *Microtis*) and *Oligochaetochilus* (Jones 2004) (= *Pterostylis*). This paper provides the necessary recombinations of these new taxa into the genera accepted at PERTH, in order that they may be dealt with adequately in Western Australia. Future short communications in this series will deal with any further taxa so described, until a broadly accepted consensus is reached with respect to the boundaries of these genera.

New combinations

Microtis cupularis (D.L.Jones & G.Brockman) A.P. Br., *comb. nov.*

Hydrorchis cupularis D.L. Jones & G. Brockman, *The Orchadian* 14(11): 518–519, Fig. 1 (2005). *Type:* Western Australia: Piney Lakes Nature Reserve, Murdoch Dr., Bullcreek, 32°02'58"S, 115°50'37"E, 13 Oct. 2000, *G. Brockman* 684 (*holo:* PERTH 06001114; *iso:* AD, BRI, CANB, MEL, NSW).

Pterostylis frenchii (D.L. Jones) A.P. Br., *comb. nov.*

Oligochaetochilus frenchii D.L. Jones, *The Orchadian* 14(10): 444–446 (2004). *Type:* Western Australia: Yalgorup National Park, 14 Nov. 1993, *C. French* (*D.L. Jones* 12623) (*holo:* CANB; *iso:* PERTH).

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Hopper, S. D. & Brown, A. P. (2000). New genera, subgenera, combinations and species in the *Caladenia* alliance Orchidaceae: Diurideae. *Lindleyana* 15: 120–126.

Hopper, S. D. & Brown, A. P. (2004). Robert Brown's *Caladenia* revisited, including a revision of its sister genera *Cyanicula*, *Ericksonella* and *Pheladenia* Caladeniinae: Orchidaceae. *Australian Systematic Botany* 17: 171–240.

Jones, D. L. (2002). New combination. *The Orchadian* 14: 71.

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K.R. Thiele[1] and A.P. Brown[2]
Department of Environment and Conservation,
[1]Western Australian Herbarium, Locked Bag 104, Bentley Delivery Centre, Western Australia 6983
[2]Species & Communities Branch, PO Box 51, Wanneroo, Western Australia 6065

Further recombinations of *Dryandra* into *Banksia*

Mast and Thiele (2007), in order to resolve a problem caused by the paraphyly of *Dryandra* with respect to *Banksia*, reduced the former genus to a synonym of the latter, and published new combinations for the majority of *Dryandra* taxa in *Banksia*. However, a paper by George (2005), describing one new species and five new infraspecies of *Dryandra*, was overlooked at the time. Accordingly, these taxa require new combinations in *Banksia*.

New names and combinations

Banksia rufa A.R. Mast & K.R. Thiele subsp. **magna** (A.S. George) A.R. Mast & K.R. Thiele, *comb. nov.*
Basionym: *Dryandra ferruginea* Kippist ex Meisn. subsp. *magna* A.S. George, *Nuytsia* 15: 337 (2005).

Banksia fraseri (R. Br.) A.R. Mast & K.R. Thiele var. **crebra** (A.S. George) A.R. Mast & K.R. Thiele, *comb. nov.*
Basionym: *Dryandra fraseri* R. Br. var. *crebra* A.S. George, *Nuytsia* 15: 339 (2005).

Banksia fraseri (R. Br.) A.R. Mast & K.R. Thiele var. **effusa** (A.S. George) A.R. Mast & K.R. Thiele, *comb. nov.*
Basionym: *Dryandra fraseri* R. Br. var. *effusa* A.S. George, *Nuytsia* 15: 339 (2005).

Banksia ionthocarpa (A.S. George) A.R. Mast & K.R. Thiele subsp. **chrysophoenix** (A.S. George) A.R. Mast & K.R. Thiele, *comb. nov.*
Basionym: *Dryandra ionthocarpa* A.S. George subsp. *chrysophoenix* A.S. George, *Nuytsia* 15: 341 (2005).

Banksia prionophylla A.R. Mast & K.R. Thiele, *nom. nov.*
Basionym: *Dryandra prionotes* A.S. George, *Nuytsia* 15: 342 (2005), *non B. prionotes* Lindl.

Banksia pteridifolia (R. Br.) A.R. Mast & K.R. Thiele subsp. **inretita** (A.S. George) A.R. Mast & K.R. Thiele, *comb. nov.*
Basionym: *Dryandra pteridifolia* R. Br. subsp. *inretita* A.S. George, *Nuytsia* 15: 345 (2005).

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K.R. Thiele[1] and A.R. Mast[2]

[1]Western Australian Herbarium, Department of Environment and Conservation,
Locked Bag 104, Bentley Delivery Centre, Western Australia 6983
[2]Department of Biological Science, Florida State University, Tallahassee, FL 32306, USA

CONSERVATION CODES FOR WESTERN AUSTRALIAN FLORA

R: Declared Rare Flora – Extant Taxa (= Threatened Flora = Endangered + Vulnerable)
Taxa which have been adequately searched for, and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such, following approval by the Minister for the Environment, after recommendation by the State's Threatened Species Scientific Committee.

X: Declared Rare Flora – Presumed Extinct Taxa
Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searhcing, or of which all known wild populations have been destroyed more recently, and have been gazetted as such, following approval by the Minister for Environment, after recommendation by the State's threatened Species Scientific Committee.

1: Priority One – Poorly Known Taxa
Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, e.g. road verges, urban areas, farmland, active mineral leases, etc., or the plants are under threat, e.g. from disease, grazing by feral aniamls, etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

2: Priority Two – Poorly Known Taxa
Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

3: Priority Three – Poorly Known Taxa
Taxa which are known from several populations, at least some of which are not believed tobe under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in need of further survey.

4: Priority Four – Rare Taxa
Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5–10 years.

Publication date for *Nuytsia* 16 Number 1: 20 December 2006

NOTES FOR AUTHORS

Nuytsia is a refereed journal that publishes original papers on systematic botany with preference given to papers relating to the flora of Western Australia. Its scope includes revisionary studies and systematic analyses of native plant groups, papers publishing new species or drawing attention to potential new invasive species, and short communications of taxonomic and nomenclatural clarifications.

Style and layout should follow recent numbers of Nuytsia, noting particularly the following.

Title. Should include the family name of genera or species treated, but not authorities. New taxa should be named if not numerous. The geographic area of study should be given where appropriate.

Abstract. The paragraph (or paragraphs) should be indented and commence with bibliographic information. New taxa, combinations and names should be listed. The major contents of the paper should be summarized but no additional material given.

Headings. All headings should be in capitals and lower case, major headings being centred and minor ones left-justified.

Keys. May be either indented (e.g. *Nuytsia* 16: 122) or bracketed (e.g. *Nuytsia* 16: 19). Indented keys involving more than nine levels of indentation should be avoided.

Species treatments. Use of certain named paragraphs, or sets of paragraphs, for matter following the descriptions is encouraged. The desired sequence and examples of commonly-used headings are shown below. Recommended headings, italicized below, should be left-justified, followed by text on the same line.

Taxon name, synonymy (if any), significant manuscript or phrase names and type details (for previously published taxa).

Latin (for new taxa - indented).

Typus: (for new taxa - not indented).

English description (indented).

Other specimens examined or *Selected specimens examined*, as appropriate.

Distribution.

Habitat.

Phenology or *Flowering period.*

Conservation status. Department of Conservation and Land Management conservation codes for rare and threatened (Declared Rare Flora and Priority Flora) WA taxa are given in each issue. Status is reviewed and assigned by Departmental staff.

Etymology.

Typification.

Affinities or *Relationships.*

Discussion or *Comments* or *Notes.*

Threatened species. It is the policy of DEC not to publish precise locality data for threatened species. Authors are therefore requested not to cite precise locality data when describing threatened species. Generalized localities should be given accompanied by the statement - [precise locality withheld].

Synonymy. Recent papers should be consulted for examples of an appropriate format for citing synonyms.

Standard abbreviations. Where abbreviations are used, the following standards should be followed:

- Author abbreviations:
  - Brummitt, R.K. & Powell, C.E. (1992). Authors of Plant Names. (Royal Botanic Gardens: Kew.)
- Book titles in literature citations:
  - Stafleu, F.A. & Cowan, R.S. (1976–83). Taxonomic Literature. Edn 2. (I.A.P.T.: Utrecht) (but with capital initial letters.)
  - Green, J.W. (1985). Census of the Vascular Plants of Western Australia. Edn 2. Pp. 2024. (Dept of Agriculture: Perth.)
- Journal titles in literature citations and reference lists:
  - Lawrence, G.H.M. *et al.* (1968). Botanico-Periodicum-Huntianum (B-P-H).
  - Green *op. cit.*

Figures. Numbers should follow a single sequence, including maps.

References. Citation of references in the text should be of the form *author's surname (year)* or *(year: page)* with full details given in the Reference section. This format is also recommended to replace the traditional abbreviations for references listed under taxonomic names, for example using Bentham (1878: 234) instead of Benth., Fl. Austral. 7: 234 (1878).

Structure of papers. Authors are encouraged to use the conventional structure of scientific papers when a complete study is being reported (e.g. a revision).

A *Methods* section should include the method of drawing up the descriptions from specimens, extent of search for types, and discussion of concepts for choice of taxonomic categories.

A *Discussion* section should be considered, which would include some or all of the following: a summary of the findings, emphasizing the most significant; interpretation of the results in the light of other relevant work; statement of new problems which have arisen; advising of aspects which are to be followed up; suggestion of topics which others might usefully pursue; prediction and speculation.

Descriptions and keys using manuscript or phrase names will not generally be accepted. All papers are refereed and the Editorial Advisory Committee reserves the right to reject papers. Opinions expressed by authors are their own and do not necessarily represent the policies or views of the Department of Conservation and Land Management.

After final acceptance of papers, authors are requested to provide final versions of files on disc or by email and readable directly personal computer . Text should be provided in MS-WORD compatible format. Within a paragraph two spaces are required between sentences; after colons, semicolons, commas and dashes a single space is required. Latin names should be italicized.

Original figures should not be lettered but accompanied by copies indicating lettering. If digital images are submitted for figures they should be at a minimum resolution of 300 dpi, preferably in a lossless file format such as TIF.

Page proofs will be forwarded to authors for checking. Twenty reprints of each paper will be provided free of charge. PDF versions of all papers will be made available via the journal's web site.

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